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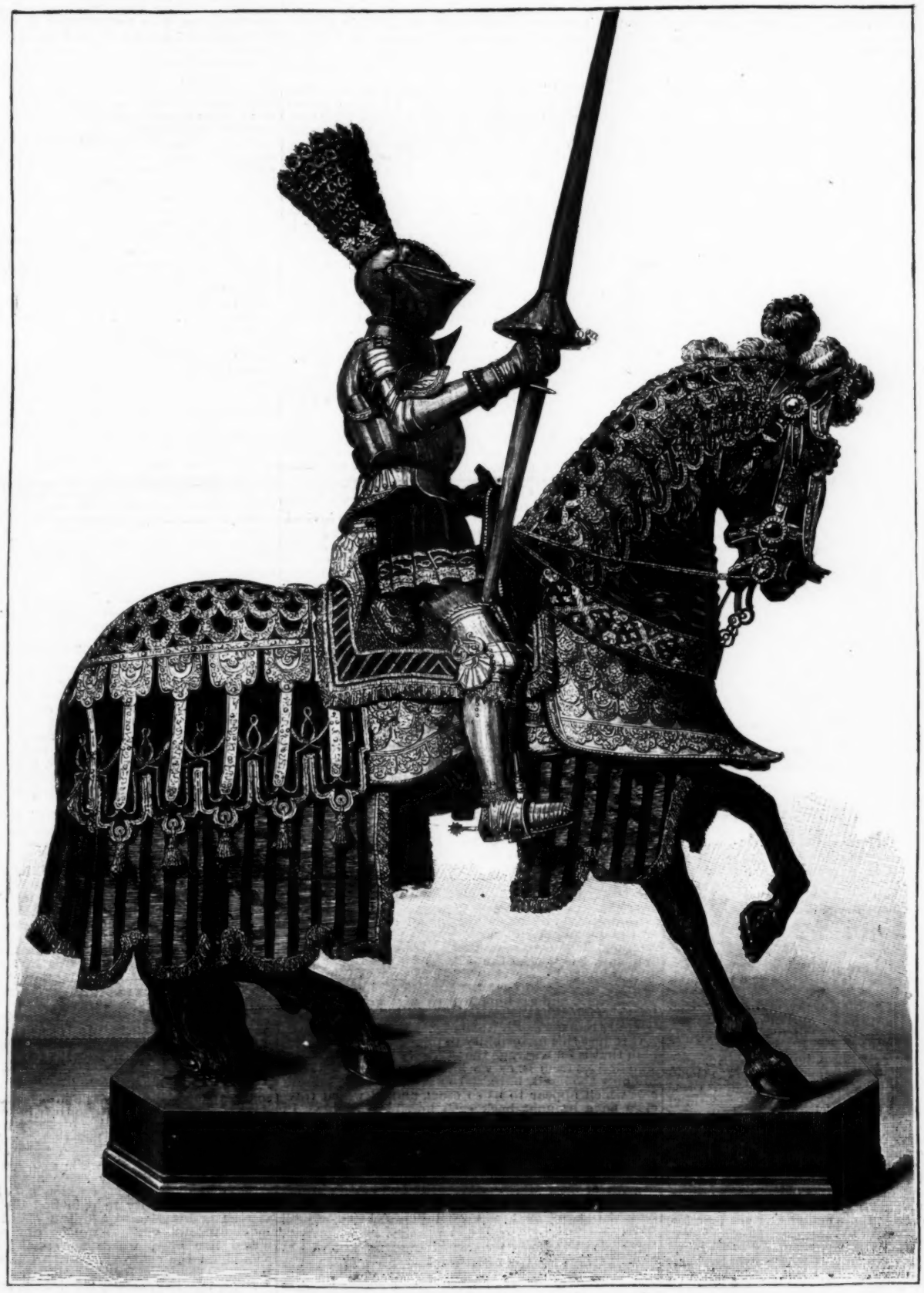

ARMOR OF CHARLES V. IN THE ROYAL ARMORY AT MADRID.

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THE Royal Armory of Spain was burned in 1884, and the late king, Alphonso XII., was greatly interested in the erection of the new structure, which has since been completed at a cost of $50,000. Alphonso realized that, in order to secure a really valuable catalogue, it would be necessary to find a man whose talents fitted him specially for work of this kind. He found such a man in the Count de Valencia de Don Juan, to whom he intrusted the task, which has been performed in a truly masterful manner, for he has given us a work that is no ordinary catalogue, but really a literary production. This truly artistic publication is also most valuable as a book of reference and offers every opportunity of obtaining a thorough knowledge of the fine collection in the Royal Armory.

Among the articles of great historic value and artistic merit described in this catalogue is the superb specimen of equestrian armor shown in the accompanying engraving, for which we are indebted to La Ilustracion Española y Americana. This armor belonged to Charles V. when he was Prince of Spain and Sovereign Duke of Burgundy (1500–1538). It is all of polished case-hardened steel and is ornamented with gilding and engraving. The armor to be worn by the man weighs about 72 pounds, and that for the horse, with the saddle, etc., as much more, so that, including the weight of the rider, the horse had to carry about 300 pounds—rather a heavy load to be carried into battle and to tournaments, where much would be expected of the beast.

GAMES AMONG CRIMINALS AND SAVAGES.*

By Prof. LOMBROSO.

IN the animal series, according to Romanes, games were first noticed among fishes,† but more recent observations show that they really originated and were common among a much lower class of animals. "I have observed," writes Dr. James Weir,‡ among the actoniferos rizogrodos, movements and acts having no connection with sexual desires or with hunger, which makes me think that these protozones have also their games and their amusements; I have often seen them chasing each other round their microscopic sea. They seem to play like children pursuing each other; the first trying to catch the second, the second the third, and so on. Very often four or five actonifores took part in the game. I have noticed among rotifera a sort of dance consisting of a single step, which each rotifera performed in his turn. In this exercise they leaped forward and backward, appearing to turn an invisible skipping rope. They continued doing this for some minutes and then rested. These rotifera have another game; using a hook with which their tails are armed, they suspend to an alga and shoot themselves upward and downward in the water.

One sees constantly also a swarm of tiny insects dancing in the sun rays. I observed one day a malicious trick of which the protagonists were two flies. One fly was sleeping under the armpit of a dog; another fly arrived upon the scene, viewed the sleeper quietly for a few seconds, then, suddenly leaping upon her, stung her, and flew away, followed by his victim.

Brehm§ describes a fête which preceded the nuptials of two spiders. It consisted of a sort of wrestling match, with leaps and bounds, having no direct connection with sexuality; gyrations, etc., that so completely tired out the male that he remained inert all that day and the following morning.

Ants sustain very real battles, and close observers such as Huber, Brehm, Lübel, etc., agree in the descriptions they give. They sit up on end, passing their forearms round the bodies of their companions and fence with their antennæ (the most sensitive parts of their bodies), try to bite, roll each other on the ground, drag each other through the ant hill, and so on. "A dozen of young queens," says Mailook, "‖ were squatted on the ground breasting the wind; they were pushing each other about, and twirling round and round to amuse themselves. The working ants took no part in this game."

Little chickens, one month to six weeks old, rush at each other in pretended, simulated, and ineffective battles.

The males of the Cupid pheasants (Fetras Cupido) of the United States, during the breeding season, while the females are hatching, assemble at dawn, forty or fifty at a time, as if for a tournament. They appear at first as if simply parading regally; they strut, they move from side to side, casting provoking glances at each other; at length the attack begins, and they go at each other with an impetuosity and vigor of incredible force, rising on two feet above the ground and uttering sharp and piercing cries.

Puppies provoke and chase each other, making believe to bite, and to fight together. Goats stand up on their hind legs and knock each other about, butting with their foreheads, and often severely wounding each other and getting much injured by falling heavily to the ground backward.

Dogs, cats, and other animals of prey bite and scratch each other at first in play, but, often becoming excited by the struggle and pain, the playmates insensibly arrive at quarreling in earnest.

"The games of the superior animals," says Spencer, "consist in simulating acts generally useful to themselves or to those of their kind." In reality, these acts, being habitual, offer an easy way of getting rid of their superfluous nervous forces. Cats and lions play with a ball, licking it and rolling it about under their feet; it is the mimicry of combat. The dog runs after imaginary foes, or makes believe to fight with other dogs. He ends by becoming irritated, shows his teeth and bites, though superficially. The struggle for life, therefore, simulated only, becomes a pastime or game. Besides the pleasure in imitation, it has the advantage of bringing into action those energies as yet inactive, and the instincts inherent to race; and, as a matter of fact, these sorts of games are particularly to be found among the species of animals in whose lives the same struggles must of necessity occur later.

With birds, on the contrary, among whom the struggle assumes a less belligerent form, these characteristics, generally speaking, are not found in their games. "Nothing is more common," says Darwin, "than the fact that animals take pleasure in practicing an instinctive act of some kind, which, under different circumstances, has to be accomplished to a useful end. The continual struggle in the midst of which their life is developed excites an instinct of cruelty; and the carnivorous and mammiferous animals, birds, fishes, reptiles, etc., consider a living prey simply as their subsistence. They are completely insensible to sufferings which to themselves are only enjoyable episodes; for these very sufferings afford a proof of a domination and a victory upon which their existence necessarily depends." Wolves and foxes play a long time with their prey,* releasing and catching it again many times. A cat, when it has wounded a mouse, licks it and seizes it again. The white headed eagle (Falco leucocephalus) emits a cry of delight when he feels the last convulsions of his victim.†

Savages.—If now from animals we raise our thoughts to savage man, we do not find an abrupt ascent, but a functional continuity, which corresponds completely to the organic continuity. Like animals, savages practice acts which are to be useful in their real life, acts of struggle and violence. "They fight," says Lubbock,‡ in speaking of certain tribes, "for the mere pleasure of fighting." This fighting propensity enters into and forms part of all their amusements, dances, balls, and songs. The negroes of Africa represent in their dances furious battles in which their adversaries, armed with sticks and assegais, pretend to contend.

In their childish games the children of savages often use arms, and particularly lances. In those places where they hunt down and take the heads of their vanquished foes, the children have a dance representing such a hunt, and the heads are parodied by cocoanuts. When, during the dance, they manage to capture a supposed skull, they offer it in derision betel nut and tobacco.

These war dances, under the form of duels, are particularly in favor among the Aspaches and Affures (Ratzel, 1 c., p. 4-24). Among the Duallas there is a very picturesque festival often to be seen, called parra parra. It consists of a series of combats in which one community provokes another, and has, without doubt, a religious signification. The combats, however, take place according to fixed rules and with umpires on the field. After a grand mimic representation and the dance is over, a dispute begins which ends in single combat.

In the time of Cook, young girls themselves participated in these warlike games, all armed, ran races and also fought (Ratzel, 1 c., p. 144).

In Queensland, South Australia, they perform dances in which they throw lances and firebrands, with ferocious and sometimes obscene gestures.

The Mic-macs (New Caledonia) have a legend§ that tells how, on a certain occasion, they were assisting at a festival of a neighboring tribe (the Rovedeches), and the children were all playing together, when one of the Mic-mac children was killed. It was considered as an accident, and no one spoke of it, but the thing was not forgotten.

A short time afterward the Rovedeches were invited to a festival by the Mic-macs. While they were jumping, dancing, and playing tennis, and when the games were most animated, the children of the Mic-macs found means to avenge the death of their companion—killing, as though by accident, two of the Rovedeches' children. Again they affected to let this pass without notice, but they treasured the deed in their hearts for future vengeance. A little while afterward a battle took place which effectively settled the question.

The youth of both sides met—at first under the guise of friendship—shook hands, asked after each other's health, and expressed a wish to organize a festival together. The Mic-macs proposed to the other side that they should go and have games on the ice, which proposal was cordially accepted by the Rovedeches.

Their war dance began at once, and underneath their feet the ice rose and fell like the waves of a tempestuous sea. The games soon became violent, they clutched each other, and fought in earnest, and finally each victor wounded his victim to the death. The Rovedeches' warriors were also all killed.

This legend proves the close relation that exists between pretended battles and real combats. In the first place, any deaths that occur during play are considered as quite ordinary events; a real fight beginning at first under the semblance of friendliness, unites in one single action the two manifestations, just as they are already united by their genesis. Savages in their love of fighting have not the smallest respect for life or the human personality, whether it regards their inferiors, their equals, or themselves. "Killing," says Williams, "is not for the Fijians an exceptional, but an habitual act, for they are accustomed from their earliest infancy to beat their mothers, ill-treat their companions, and eat human flesh." "To the Australian aboriginal," says Ratzel, "to be killed in battle is the only natural death" (page 78).

It is just this insensibility to physical and psychical pain that is for a savage the necessity of his existence; who derives from it, as we have seen among animals, not only the habit, but also the pleasure they take in acts which appear to us so cruel, and of which travelers have brought back such horrible accounts. In Senegambia, writes Letourneau,‖ and one can say the same of all savages, there is a great complacency in viewing the sufferings of others. Besides, the sentiment of respect for life and personal integrity, which appears to us so instinctive and so strong, is only the growth of later times. At epochs and among people very near us, it was no more felt or respected than among the savages; and even to-day people of all races and of all social ranks not only assist with indifference, but even with pleasure, at the sufferings of others.

Thus, side by side with the indolent, languid games of the Orientals, in connection with these people flourish the bloody rites of the Brahmins, Buddhists, and Juggernaut. The great shooting and hunting expeditions, organized like real military campaigns, and attended with great peril, were the survival of the most tenacious and ancient customs in the higher parts of Oriental Asia, and the nomadic people who lived in Europe fourteen centuries ago were like the same people of our own time, Nomads, Tartars, Kirghises, and Arabs, who to this day expose their lives for sheer amusement.

The gladiatorial fights in Rome, in one of which Trajan caused 10,000 gladiators and 11,000 animals to be killed, and the celebrated games of the Greeks had only one aim—the satisfaction of the voluptuous love of violence and lust of blood.

The Italian towns of the middle ages, unceasingly torn to pieces by internecine disorders, divided themselves into factions for games.*

In the neighborhood of the turbulent France of the Valois and the Huguenots, the amusements of the people, as of the great, were the chase, fencing, and tournaments. In 1212 they made in Italy a number of dungeons in which young men of rich, noble, and princely families died. On the buckler of one of these cavaliers was found engraved this device: "If I drown myself in blood, oh, happy death!" During the Commune, the games preferred by the people were pugilism, kicking, throwing hard balls, and entering the lists, etc. In a bull fight at Rome in 1333 there were eighteen killed and nine wounded. At Pisa, in the eleventh century, in honor of the defeat of the Saracens and as a memorial, they celebrated the battle of the bridge. The town was divided into two factions, the Bianchis and the Borgos. They fought with great bucklers and shields of wood. The victor was he who escaped from the adversary and remained master of the bridge.

Aguelli speaks in his "Life of the Archbishops" of a popular game at Ravenna, in which old and young, women and children, went outside the town and fought ferociously with each other; he also remarks that in 690 there were as many dead and wounded as though there had been a real battle. Manzi, 1 c. We find traces of these sort of games in the cruel and dangerous pastimes usual a little while ago at Ravenna and in all the Romagna, and which Ferrero speaks of.†

In Spain, where the children play at bull fighting and give each other blows on the head and beatings with sticks which represent the lance, a troop of young men belonging to Valencia made a knife take the place of the stick, and fastened two knives on the head of the one representing the bull to portray his horns. The game was in reality, therefore, war to the knife; several were killed and many were wounded, a torrent of blood was spilled without anyone taking exception to it or opposing this massacre.‡

All these games are the remains of the cruel and quarrelsome animal instinct that civilization has not yet rooted out in modern man, and which reappears in all its brutality the moment it is not restrained by moral and social laws.

This is so true that often, just as happens in the games of animals, this instinct is roused by the energy of the mimic game, or following a well-known law in psycho-pathology, by the outward attitude which provokes internal and corresponding sentiments. Pastimes then transform themselves into real and sanguinary battles to such a pitch that in 1548 the town of Genoa clamored loudly for the suppression of games; they so often ended in stoning and otherwise injuring the combatants.

According to Muralois, from 1199, St. Pierre Parenso exhorted the Orviellians to abstain from committing homicidal acts during play time!

II.—GAMES AMONG CHILDREN.

Two tendencies can be observed among children—to exercise to the utmost their muscular energy, by screams, races, quarrels, and cruelty. They wish to do harm for harm's sake. Thus one of their greatest pleasures is to persecute old men, imbeciles, the weak, and to torture animals; for instance, set fire to beetles, pluck the feathers from a bird, make shuttlecocks of certain animals, such as rabbits, and to catch butterflies in a trap, beat dogs, strangle swallows, cover beetles with wax. In Spain they torture the dying bulls.

In our own epoch, in a civilized nation, Germany, certain cultivated individuals, such as students, practice dueling without any reason save that of amusement, following the caprices of the heads of the societies to which they belong; and the most dogged and intrepid duelists are considered as the greatest ornaments in these societies. They insist on the newcomers (called Fuchs) submitting to these duels to prove their courage and their power of supporting pain. If they do not show courage, they remain Fuchs, and are not considered as holding the same rank as their associates, just as savages forced their children to go through painful ordeals when they reached adolescence to prove their right to rank with men.

The German students glorify themselves over wounds received in these duels. It is their title of nobility; some of them irritate their wounds with applications of some acid while they are yet raw, in order that the scars may be deeper and more permanent.

One finds also in the games of strife in young men's colleges sometimes very painful experiences among some of them, who, owing to their incomplete physical development, approach more nearly to the primitive conditions of existence, but these probations are always less severe than those I have observed among criminals. Only a little while ago could be observed in Paris habits evidently analogous to the vestiges of that barbarous world in which he who showed the greatest insensibility to pain had the best chance of victory, and was consequently admired and respected by his fellows, vestiges wonderfully persistent in an epoch like ours, where an exquisite sensitiveness should, on the contrary, be appreciated as the most favorable condition for any struggle.

Flint, who has recently studied the curious organiza-

* The Humanitarian.
† Romanes. "Mental Evolution Among Animals."
‡ "American Naturalist," Ottawa, 1894.
§ Brehm. "Life and Habits of Animals," Vol. I., page 200.
‖ Cited by Romanes in his "Animal Intelligence," pages 83-84.

* Brehm, op. cit., Vol. I., page 453.
† Audubon. "Ornithological Biography," Vol. I., page 161.
‡ Lubbock. "Prehistoric Times."
§ "Archives of Anthropology and Ethnology," 1894, Vol. XXIV., part III.
‖ Sociology, page 14b.

* Bonardi. "Festivals, Games, and Plays."
† Manzi. "A Discourse on the Play, Festivals, and the Luxury of the Italians," page 7, cited by Mantegazza, festivals and drunkenness.
‡ De Amicis. "Spain," page 422.

tion of the clubs of criminals in America,* remarks that the clubs organized by criminals (in argot the indigenous) pass their time in fighting against opposition clubs. They practice these fights in their places of rendezvous and study special tactics. Flint speaks of one encounter between two of these clubs, which lasted but one quarter of an hour, yet resulted in clothes torn to rags, broken noses, and eyes blackened, etc.

III.—CRIMINALS.

I have obtained from certain prisoners a description of some games they organize and practice in their houses of correction. Hardly does the surveillance become a little relaxed, than all the prerequisitions and precautions become useless, particularly in those establishments where the prisoners have employment and work. They always join together invariably, and always manage to arm themselves with sharp-pointed nails, little bits of pointed steel, sometimes even with knives—which they conceal very ingeniously—to utilize at an opportune moment, especially in their pastimes. One of their games, and one which appears to me highly characteristic, is the one which in argot is called the patta. One of the players takes in each hand a little stick in which is fixed a sharp metal point. He stretches out his arms and brings his hands round within a little space opposite each other. The cleverness of the players consists in getting their heads in between the points without being touched. If they do not achieve this, they receive atrocious scratches on the temples and face, and only sometimes leave off the game when they have had fifteen or sixteen cuts, of which they bear the marks for a very long time.

In another of their games, one of the players with bandaged eyes places the palm of his hand downward on the table, with the fingers stretched wide apart. The others strike quickly and in succession with the same sharp-pointed instrument in the spaces between the fingers. If, as often happens from the rapidity with which the blows are given, the point enters the fingers, the rôles are changed, and woe to him who shirks it. They affirm that at no time are the wounds deep or severe, because they say the metal points are short and do not penetrate deeply.

The game of the "wheel" is not less cruel. Twenty or thirty young men range themselves in a circle and run round rapidly after each other. One remains outside the circle armed with a very heavy stick or a bit of iron, with which he tries to strike the runners as they accelerate or diminish their pace, and by stooping try to avoid the blows. Even the innocent games common to our children assume among them a ferocious character.

One blindfolded, as in blind man's buff, tries to discover his comrades, armed with a handkerchief in the corner of which is tied a stone, or a wooden ball, or a piece of iron, even a piece of hard, dried bread. The moment he fancies any one is near enough he strikes with his utmost strength, sometimes wounding severely with his projectile.

It is the same in a game called porta gallotti, in which the individual blindfolded has to guess who touched him and whom he has caught.

Instead of the usual innocent forfeits in the event of a mistake, blows on the hand are given of so violent a nature that the services of a doctor have often to be called into requisition, to dress the swollen and bleeding hands.

Besides the suffering this punishment necessarily causes (all for a mistake in a game), it must be remarked that the localization of the punishment just on the hands that have erred is a reminiscence of the primitive state, and of the conscience of his own personality, in which the different members of the body were considered more or less as acting independently of each other and consequently separately; thus being individually responsible for their acts, and not as though belonging to one united and sole organization.

The game of "cat and mouse" played by our children also assumes among these others the form of a very real fight. When the pseudo cat catches the mouse, he profits by the occasion, and inflicts such severe blows as to draw blood from his companion. In another game, all but one bend forward, and the player throws a wooden ball (more often, as previously explained, a stone tied up in a handkerchief) through the legs of those in front; the victory is to him who can throw it farthest, and he has the right (of which he always avails himself) of punishing those he has vanquished by striking them with the stone.

In the game of scari cobarile one of the players carries another pickaback on his shoulders, and asks him whether he wishes heads or tails. If the unhappy one says heads, he is instantly dislodged, and thrown violently on the ground head foremost. In the very innocent game of skipping rope they manage to give themselves severe and dangerous injuries, as you can judge by the horror with which this game is recalled. When the player has thrown himself forward to jump over the rope held by two comrades, it is suddenly jerked upward, and of course the player is also thrown violently to the ground. The same thing occurs in the game of stirabeaccola, when the player is leaping on the back of another he springs up suddenly so as to throw him heavily on to the ground. Of the primitive struggle for supremacy, of the heat which explains, if it does not justify these cruelties, not a trace remains. There is only a vile and cruel instinct lying in ambush, evidence of the moral anomalies of the criminals of whose natures these games give a faithful reflection.

Duplicity.—Duplicity shows itself in the manner in which they do the honors of their abode to any newcomers, naturally ignorant of the habits of the place. Several games are contrived for this purpose; in the one called le débat (the debate) the newcomer is conducted before an improvised tribunal, a cloth is laid under his feet. The tribunal judges his faults real or imaginary, and the moment his inevitable condemnation is pronounced, the cloth is suddenly pulled away, and he falls heavily to the ground.

So in the game of smuggling, the newcomer is taken on the back of a companion who pretends to have a bale of goods, and to try and pass the custom house officers, but his companions (as good officers) stop him at once, and ask him what he has in his sack. When the conventional answer has been given, "A bag of nuts," after a short discussion all the smugglers and officials set upon the newcomer and overwhelm him with merciless blows from their clinched fists. The same characteristic duplicity is found again in another pleasantry of a more complicated nature, equally shown toward the uninitiated.

In certain seats pierced with holes a needle with a long thread is introduced into one of the holes, the thread retained in the hand of another. When the newcomer is seated, the thread is suddenly tightened, of course with the effect of driving the needle often deeply into his flesh.

In other games the power of supporting pain is an absolute condition of supremacy.

Thus one of the players places his closed fists upon a table, holding in each hand a needle tightly clinched in such a way that only the points stick up. The other player then rains blows on the doubled up fists with his own clinched hands, and the game is to prove who can support the pain the longest, the one who is struck or the one who gets pricked.

Besides, in another way they undertake to show in their own persons a similar analogy, for they have a habit, from pure bravura, of literally hacking their fingers by deep incisions, making oblique cuts on the forefingers, sometimes taking out three-cornered pieces of flesh so as to leave an empty space, and these scars —in their society—are considered as much a source of pride and ornament as in ours are the wounds received in battle.

While an Indian fakir was exhibiting in the theater at Turin, and was showing the insensibility to pain produced by a special state of fascination (or hypnotism), the young men of a neighboring prison showed the same results without any special preparation, piercing the tongue, the cheeks, the arms, and the fingers with needles. The principal factor in all these games, which are almost exclusively the only games played by criminals, is the love of fighting for the sake of fighting, and seeking to wound and to receive wounds, often dangerous ones. If play is considered as arising from the overflow of an activity required by life, it is evident that in criminals this activity is specially matured.

It has already been remarked regarding them, that they have an agility and a suppleness in their movements which is abnormal, and which testifies to a high development of the motive centers and often the ventral centers. And often this physical energy (not proportionately utilized in their lives) finds outlet in their games.

The triumph of brutal physical force and the admiration it excites among themselves are both of course phenomena common to the life and in the psychology of criminals, and in reality constitute a retrogression to the primitive state of civilization which is characteristically manifested in the docility with which they submit to the brutality of the victor. Even in their games they acknowledge the supremacy of physical force and the "droit du plus fort" of the muscles.

The popular French proverb has already told us that "jeux de mains, est jeux de vilains" (only a low fellow uses his hands instead of his wits).

The Camorrists have a pleasantry in which a declaration of love is sometimes mixed up with wounding the object of their affections. When their mistress tries to withdraw from their dominion they mark her on the face with a little gash, in such a manner, however, as not to disfigure her. This is considered as a jest and a proof of their love.

Games, therefore, take a prominent part in criminal activity, as we have already shown them to do in animal and savage life; and as with them it often passes beyond the border in the case of criminals. We find proof in the case of the criminal, cited by Macdonald,* who began throwing snowballs at an old woman, and then, excited by her cries, put stones in them, broke her arm, wounded her head, and never stopped till someone arrived upon the scene. It is in reality the fact that criminals feel less themselves, that they are unable to understand the sufferings of others, and commit acts which appear to us so uselessly cruel. It is like a drunkard whose taste is vitiated by the abuse of alcohol and who always experiences a craving for a still stronger stimulant; their nervous and physical systems being insensible to usual and common impressions, crave for the stimulant of an excitement still more painful. For this reason their games present, in an exaggerated degree, the cruel character which we have been showing as existing among animals, savages and children, who enjoy tormenting animals and those weaker than themselves.

If criminals, therefore, choose cruelty as the elective form of their activity, it is because it corresponds with the secret intimate psychological nature which rebels against all progress and against moral sentiment. This manner of acting has the satisfaction of giving to each organism the exercise of the particular function which is individually his.

* Review of Reviews, April, 1895.

* Cited by Hervieu, "Homicides," p. 589.

THE HASSELMANN PICKLING PROCESS FOR MINE TIMBER.†

LARGE sums of money are spent yearly for mine timber; and, even when impregnated by existing methods, it does not resist decay for more than four or five years, while this length of time is put rather high. If, however, the timbers be subjected to a closer test, it will be found that some of them have already lost considerably in strength after less than two years, so that in all probability it will have been found necessary to replace them before that period.

The object of this paper, however, is not to indulge in economical considerations as to timber consumption, but rather to ascertain and determine how those industries that use wood, and especially the mining interest, can best and longest maintain this valuable substance sound and fit for use.

Untreated timber must now be considered as unsuitable for mine use because, with the special conditions of temperature that prevail in mines, the timber, on account of its slight resistance to damp, even when taken underground in a dry state, soon begins to decay and must in a very short time be replaced.

Let us now consider the methods hitherto most employed, viz., kyanizing and the chloride of zinc process. The former, named after its inventor, Kyan (1820), consists in treating, with an aqueous solution of mercury chloride, the timber inserted in wooden troughs, which are filled with the above-named solution, and in which the timber remains—fir wood from eight to ten days and oak from twelve to fourteen, although the process may be hastened by raising the temperature of the solution. Now it is perfectly true that mercury has a deadly effect on the protoplasm of fungoid growth; but kyanized timbers, on account of this mercury content, are again capable of poisoning, so that they are only suitable for sleepers and other similar articles. Kyanizing, therefore, labors under the following main disadvantages: (1) It is too tedious an operation; (2) it reduces the value of the timber from a chemical-technical point of view; and (3) it is injurious to health.

1. As will readily be seen, and as is also shown in treatises on the subject, the kyanizing process, with its introduction of the timbers one by one into the solution, the necessity of preserving spaces between the several timbers, in order to insure access by the fluid to the whole of the surfaces, the fixing down of the timbers so as to prevent their floating, the necessity for continuous stirring, a daily verification of and adding to the solution in order to maintain it at a sufficient strength, as also a drying of the freshly cut timber before it is introduced into the solution—all this is evidently too tedious.

2. As is stated in the description of the process itself, the solution does not penetrate throughout the whole substance of the wood, but only for about a centimeter ($\frac{1}{3}\frac{2}{8}$ inch) in the sap wood (and not at all in the heart wood), where it combines with the albumen, arresting decay. The author had the opportunity of seeing a kyanized telegraph post which had broken off short just above the surface of the ground, and which was completely decayed inside. Inasmuch as the mercury solution prevented the entrance of decay from outside, the wood, owing to insufficient drying before the impregnation, chiefly decayed from the inside outward; accordingly the decay ensued from the inside to the outside; and, although it was not manifest, the strength of the post was so far reduced that it broke off in a strong wind. It follows that this penetration of the solution to the depth of a few centimeters only cannot but render the impregnation illusory. In addition to the circumstance that a mechanical deterioration of this thin protecting coat from the outside toward the inside at the same time does away with any resistance of the timber to decay, the wood thus treated only on its surface very soon loses its resistance to decay. In the absence of heated impregnation and drying chambers, kyanizing is only possible in the warmer months, because the corrosive sublimate, the solution employed, will only stand a certain temperature; and it must also, on account of its sensitiveness, be protected from the action of light, which still further increases the tediousness of this process, while at the same time the strength, especially in the inside of the timber, will be none the greater.

3. As regards the health not only of consumers, or those who may be engaged in the spaces or chambers formed of kyanized wood or lined therewith, but also of the producers—the men engaged in kyanizing works —the process is injurious in the highest degree; and in this respect there is no need for any long dissertation, as it is only necessary to glance at the descriptions and precautionary measures which those carrying out the process are obliged to observe. The complaints and the appearance of men engaged in it show all the signs of mercurial poisoning.

The so-called chlorate of zinc process, which is largely employed for impregnating sleepers, is performed in the following manner: The timber is introduced into a receiver, which is then closed so as to be air-tight; and an air-pump extracts all the air from the receiver and from the pores of the wood—an operation which lasts from two to three hours. The chloride of zinc solution is then allowed to completely fill the receiver, when an air-pump forces the solution into the pores of the wood; and, after the pressure is taken off, the timber is taken out and exposed to the air for drying.

The whole operation is preceded by the action of a current of steam at the temperature of 112·5° C. upon the wood for one hour, if it is dry, but for two hours if not quite dry. The disadvantages of this process are the following:

With this process also, oak, fir, and pine woods are not thoroughly impregnated; but the chloride of zinc solution scarcely penetrates two centimeters ($\frac{1}{3}\frac{2}{8}$ inch) into oak, and in the other woods only into the sap wood, leaving the heart almost entirely unimpregnated. The beech, which is capable of taking up far more chloride of zinc, although it can also give up this substance again very easily, can only be employed for industrial purposes when very carefully chosen, because up to the present time it has not been found possible to impregnate the so-called gray or red heart of beech, which cannot take up any of the impregnating substances hitherto employed. The untreated places therefore always form the starting points of decomposition, or destruction through decay.

A third process, largely employed for railway sleepers, is injection with tar oil. Inasmuch, however, as this process also is only a mechanical one, it cannot either effect a complete impregnation and penetrate the red or gray heart of beech, nor impart to the timber a greater degree of hardness, so that its action is very limited as regards durability and resistance of the timber to wear or pressure; and, in addition to this, there is the danger of increased inflammability. On that account, therefore, this method of pickling must be regarded as absolutely inapplicable to mine timber.

It follows that the three methods of timber impregnation which are most employed give but little satisfactory result, and have not solved the problem of timber preservation generally. It is, therefore, all the more satisfactory that quite lately a method has been discovered which has effected a solution of the problem in another manner. Whereas hitherto endeavors were entirely directed to filling the cavities in the wood with a foreign substance more or less antiseptic, in the new method not only are the cell walls and the wood fiber itself penetrated by the preservative, but a chemical combination is even set up directly between them and the dissolved chemical constituents of the impregnating substance; and this object is attained by a double boiling that lasts three or four hours, during which

† From a paper read before the Munich Bergmannstag, or Miners' Congress, by Dr. Max Krause, engineer, of Berlin.

solutions of (1) the cupriferous sulphate of iron and subsulphate of alumina, and (2) of calcium chloride and corrosive sublimate, are introduced into the wood and chemically combined in a closed vessel, at a temperature of 135° to 140° C., and, therefore, under a pressure of 2¼ to 3 atmospheres (mean 41 pounds per square inch).

The resin in the wood is dissolved and decomposed, the fungi of the fibers being completely destroyed; and all cells, even the innermost in the false heart of beech, are reached, and enter into indissoluble chemical composition with the impregnating chemicals.

The method originated with Herr Fritz Hasselmann; and Prof. J. E. Weiss, an authority on this subject, spoke of it as follows, on March 7 last, to the Munich Polytechnic Association: In the methods for preserving timber, etc., that have long been employed, people were content with inducing a physical impregnation by coating with, or better still by dipping in, cold or at most hot solutions, or by soaking the timbers, sometimes with the application of pressure; and the preservative substances were, so far as might be possible, deposited on the cell walls and in the cell spaces, although they might, precisely on that account (since they remained in the easily dissoluble state), be just as easily washed out with water. According to the Hasselmann method, on the contrary, a chemical combination of the impregnating materials with the cellulose and any particles that may be contained in the cells is induced by repeated boiling, that lasts several hours; and already a superficial inspection of timbers impregnated in accordance with this method shows by the color that copper and iron are no longer present therein as sulphated compounds, while a closer examination immediately convinces us that a chemical change has taken place. If, for instance, sulphate of iron still remains in that state in the timber, on adding ferrocyanide of potassium, Prussian blue must be immediately formed, which, however, is not the case; and the characteristic blue tint is only perceived in these preserved timbers on the iron being dissolved from its organic compound, while it is only on muriatic acid being added that timbers impregnated with ferrocyanide of potassium assume a fine blue color.

This coloring, that may be imparted to even the thinnest microscopical slices, also proves, in the clearest possible manner, that the walls of the wood fibers are impregnated through and through, while the hollow spaces of the cells are absolutely free from impregnation; but it is not sufficient, as many unsuccessful experiments have shown, to simply boil the timbers in the impregnating fluid. Complete impregnation can only be effected, according to the Hasselmann method, when the boiling is so effected that the impregnating solution, together with the timbers contained in it, be raised to a temperature of about 125° C. under a pressure of about 2¼ atmospheres.

If the impregnation be only a physical one, the substances introduced during the boiling must be again washed out. Now, an intense boiling, for four hours, of timbers impregnated by the Hasselmann method had the result that the chemical substances were not lixiviated; but, on the contrary, the timbers so treated retained their properties and even became harder. Owing to want of knowledge as to the chemical composition of wood fibers, it is at present impossible to determine what chemical composition is set up by the impregnation; with treatment by acids, however, iron can certainly be dissolved, but not the substance of the wood fibers.

If washed-out compounds be apparently found in the water wherein the treated timbers are boiled, it must be borne in mind that, at the moment when the impregnated timbers are taken out of the boiler, the cell spaces are filled with the dissolved impregnating substances, which, on removal of the pressure and on the heat falling, can evidently no longer be combined, so that they may naturally be washed out by any further boiling.

This circumstance affords a striking proof that the Hasselmann method is the only possible form of impregnation that can be imagined, because all the circumstances connected with it take place according to easily explained natural laws.

To this the author adds that, not only all kinds of wood, but also all vegetable and textile substances generally, can be treated by this method with the most manifold advantages—mine timbers and railway sleepers, building timber for marshy ground, etc.

That timbers impregnated in accordance with the Hasselmann method really do resist decay to a remarkable extent is proved to evidence by the trials carried out by Prof. Rösler, director of the Austrian State testing station at Klosterneuburg, which were begun in April, 1897, and concluded during the present year.

Inasmuch as these tests could not be extended over a long period, the conditions for the timber experimented upon were made as severe and unfavorable as possible, in order to make up, by intense action during a short period, for the usual effects of long duration.

For this purpose a water off-take was selected which is wet for the greater portion of the year, being only dried up for a few weeks in the height of summer, while being for the most part frozen hard during winter. In this watercourse, in April, 1897, stakes, impregnated according to the Hasselmann method, were driven into the ground, alternately with others not impregnated, for comparison; and in March, 1898, the first inspection was made, with the result that the treated stakes, of no matter what wood, had remained completely intact, and even those portions which were underground had even become harder, while there was no mildew on any of them.

With special minuteness were the portions examined where the stakes issued from the ground, because it is found that stakes generally suffer at this place from germs and micro-organisms. Small pieces cut off at this very place showed not the slightest change for the worse; but, on the contrary, it was found that the wood had increased in hardness in proportion to its depth from the surface.

The untreated stakes, put in for comparison, showed different appearances, according to the wood of which they consisted. The portions of fir stakes that were driven into the ground had, without exception, become spongy, and for the most part were very much mildewed, it being possible to divide the substance with the fingernail. The beech stakes had also become spongy in places, if not throughout like the fir stakes; and they also showed some mildew. The oak stakes were specially attacked at the place where they issued from the ground.

The results of these trials, which are concordant with his own, led Prof. Weiss to express his conviction that the Hasselmann method cannot be improved upon—an assertion which is also made by Prof. Heinrich Mayer, who proved by actual trial the impossibility of there being any fungoid growth in Hasselmannized timber, and observed that "the timber thus impregnated retains all the properties which are so important for application in the arts, especially its elasticity; and after being thus preserved it attains a degree of hardness that would have been thought impossible without a considerable increase in weight. The combustibility is also very greatly reduced, while a high capability of receiving polish is attained."

These remarkably favorable properties (concludes Dr. Krause) constitute the new invention an epoch-making one that cannot fail to leave a deep mark in the timber industry, while causing such a reaction on economical conditions as is at present difficult to estimate.

THE SALAMANDER.

FOR the following interesting account of a salamander and its habits, by Dr. K. G. Lutz, as well as the accompanying engraving, we are indebted to Vom Fels zum Meer:

THE SALAMANDER IN DIFFERENT STAGES OF DEVELOPMENT.

My salamander had spent his life in a little hole under the roots of a tree near Stuttgart until one rainy April day, when it went out to look for earthworms, and I found it and carried it home. I saw at once that it was a fine specimen of the female of the species Salamandra maculosa Laur. It was more than seven inches long, and its skin was glossy black, with two rows of yellow spots. As I had long wished to study the development of this species, I decided to make my specimen a prisoner. I arranged a comfortable dwelling for it by filling one-half of an empty aquarium with stones, which I covered over with moss, while in the other half I placed a good-sized receptacle for water. Here the little creature seemed perfectly happy, spending its days under the moss and coming out at dusk in search of earthworms, snails, caterpillars, and other choice morsels. It seemed as if it might have enjoyed its food better if its teeth had been larger, for, although the salamander has two rows of little two-pronged teeth in its upper jaw and S-shaped lines of teeth in its palate, they are so small as to be of comparatively little use. Its food was really "swallowed whole;" but it was surprising to see how quickly an earthworm, or some other dainty, almost as long as itself, would disappear.

I could not find any indication of special intelligence in the salamander, but I did not take that ill, for I realized that very little should be expected of creatures endowed with an inferior brain.

One day the salamander's skin cracked all around its mouth, loosened gradually, and then was slipped off. In less than half an hour it had literally "jumped out of its skin," and then what? After examining its cast-off garb for a moment, it ate it up without further ceremony.

Many claim that the salamander is venomous and that, therefore, it should always be treated with proper respect. It is true that its numerous glands, especially those located near the ears, secrete a watery fluid, resembling the sap of the euphorbia, which causes inflammation when brought in contact with the mucous membrane; but this fluid is secreted only when the salamander is disturbed or hurt, and so, if let alone, he will harm no one. However, the fluid is a deadly poison to small creatures, in proof of which Dürgen tells us in his book—"Deutschland's Amphibien und Reptilien"—that a lizard which bit a salamander died soon after, and that the fish in an aquarium were killed by the fluid secreted by a salamander when dying. This fluid is the only weapon of defense possessed by the little creature, which is otherwise perfectly harmless, and we certainly should not begrudge it that source of help in its struggle for life.

Early in May my salamander brought into the world twenty-five little salamanders, each a little more than an inch long. I put them into an aquarium provided with aquatic plants, where they seemed very happy. When a day and a half old, they were like the two little figures in the lower right hand corner of our engraving. They were all dark gray on the back, while underneath they were almost colorless. When about a month old, there was a slight shimmer of gold along their sides and tails.

The larvæ of the salamander differ from those of the tritons in being provided with all four legs at birth. The skin on the under side of the body of a young salamander is so transparent that its internal organs can easily be seen. Its head is broad, and the gills on each side of the head are provided with fringes, and its tail carries a fin which extends to the middle of its back.

The next question to be solved was the feeding of the little things. In all ponds, especially those which contained decaying vegetable matter, there are a great many small creatures, such as water fleas and other members of the cyclopidæ and cypridæ families. Quantities of them can be gathered by means of a small net, and in this way I obtained all I needed for my little salamanders. What a hurrying and skurrying there was among them when their prey was placed in the aquarium! They showed an agility and energy that would never have been expected of the slow, lazy salamander. At first they threw aside those with double shells; they were not yet able to manage them, but as they grew, they could take larger creatures and even pieces of meat.

When seven or eight weeks old they were as large as the larvæ in the lower left hand corner of our engraving. From that time on they changed in color and form. They lost the shimmer of gold as they grew darker, and the yellow spots began to appear, being noticeable first on the legs and about the eyes and ears; then the fin on the tail vanished, the gills shriveled, and the body became rounder. Then the larvæ came constantly to the surface of the water for air, showing that their lungs had developed. In a few days they began to climb out of the aquarium onto the rocks, and from there they were moved to the terrarium.

At this stage of their growth they were like the two young salamanders at the right of our picture, not differing essentially from the full grown salamander in shape and color, nor in their habits, for they had lost their vivacity. They remained hidden most of the time, and showed signs of life only when there was something to eat. But these young salamanders were soon given their liberty, so that they might be able to procure an abundance of food, and put themselves in condition for their long winter sleep.

Early in August I discovered a pool of water about six feet square and three feet deep, that was full of salamander larvæ which had reached that stage of transformation when they came frequently to the surface of the water. They must have found plenty to eat in that pool, for they were much larger than mine had been at this stage of their existence. Their skin was dark brown, spotted with light grayish yellow, and the gill fringes, which were remarkably large, were rust red. Two of these larvæ are shown in the center of the engraving at the right and left, and in a few days they developed so as to be like the larger of the two young salamanders shown. The young salamanders, like their elders, are seldom out of their hiding places, except at night, when they go forth in search of food. They grow slowly, requiring several years for their complete development.

The salamanders owe their name to a superstition of the old Romans, that they were not only capable of passing through fire without sustaining any injury to themselves, but that their presence would extinguish the fire. They were supposed to possess many supernatural attributes, and alchemists even tried to obtain gold by burning them. For centuries these harmless little creatures have had to endure much on account of these old superstitions, but now science, it is to be hoped, will relieve them of their burden.

HOW TO GROW MUSHROOMS.

WILLIAM FALCONER is the author of an interesting pamphlet entitled, "How to Grow Mushrooms," which is printed as the Farmers' Bulletin No. 53, published by the Department of Agriculture, under the supervision of the Division of Vegetable Physiology and Pathology, from which we condense the following:

The mushroom in commerce is practically the fruit of the mushroom plant, and not the plant itself, as some might be led to believe. The plant proper is a white bluish mould that grows in fields and manure piles. In its young stage it becomes a network of white threads, and it is from the joints of these threads that the mushrooms spring. In growing the crop, therefore, it is important to keep the plant alive and spreading, and where this is done the production of mushrooms is sure to follow. Mushrooms are a winter crop, coming in from September until April or May—that is, the work of preparing the manure begins in September and ends in February, and the packing of the crop begins in October or November and ends in May. Mushrooms are very easy to grow, and beginners are often as successful with them as are those having extensive experience. Success depends upon general conditions, heat, materials, interest in the business, intelligent management and persistent application. Aside from preparing the manure and making up the beds, it is a clean crop to handle and occupies little space and can be done by the women of the household. Unfortunately, the whole procedure of growing mushrooms has been shrouded in mystery, and it is even believed that mushrooms have to be grown in midnight darkness, but this is a mistaken idea.

The dark-colored powder produced in great quantity and diffused from the gills of the mushrooms is what is called spores. These are equivalent to the seeds of higher plants, but raising mushrooms from spores or seeds is Nature's business, and in artificial cultivation they are never grown in this way, but instead are propagated from pieces of living spawn. Our first engraving shows a lump of English or brick spawn. Each piece is broken into several pieces and then planted. Each piece will, under favorable conditions, start into new life and spread and eventually produce mushrooms. Only two kinds of spawn are in general use by our mushroom growers, English brick and French flake, both of which are imported. Of late years there is no good home-made marketable spawn. The English brick spawn is put up in bricks of dry dust and manure, measuring $8\frac{3}{4} \times 5\frac{5}{8} \times 1\frac{5}{8}$, weighing 1 pound $4\frac{1}{4}$ ounces. The manure in the brick has no virtue of itself, but is simply the host for the white spawn; the more spawn in the brick, the better and more potent it is. The bricks are not planted whole, but each is broken up into twelve or fifteen pieces. The French flake spawn is imported in flakes of dry, strawy horse manure, loose in bulk or in three pound boxes. The flakes are broken into pieces about two or three inches square and are planted in the same way as the lumps of broken spawn. Spawn is kept in stock by all prominent seed stores, and costs 10 or 12 cents a pound for the brick spawn in small lots, and the French flake spawn costs 35 to 40 cents a pound in small quantities. 320,000 pounds of the brick spawn are imported annually, while about seven years ago the import amounted to only 64,000 pounds. This shows that mushroom growing has increased fivefold since 1890. Mushrooms can be grown almost anywhere out-of-doors, and also indoors, where there is a dry bottom on which to place the beds, where a uniform and moderate temperature can be maintained, and where the beds can be protected from wet, winds, draughts, and direct sunshine. To grow mushrooms for private use they should be cultivated only under the most favorable circumstances. Among the most desirable places in which to grow mushrooms are barns, cellars, and greenhouses and regular mushroom houses. Total darkness is not imperative, for mushrooms grow well in open light if shaded from sunlight. The temperature and moisture are more apt to be equable in dark places than in open light places, and it is largely for this reason that mushroom houses are kept dark. A cellar is an excellent place to grow mushrooms, if the floor is free from water. It does not matter whether it is made of cement or wood; the windows and doors should be closed up and darkened. In case only a part of the cellar is devoted to the beds, this portion should be partitioned over with boarding, and if this is impracticable, the beds themselves should be covered over with mats, straw, etc., and boarded up as shown in Fig. 3. If the cellar is not heated, the beds should be built on the floor only, and should be 14 inches deep. If the cellar is heated, besides the beds on the floor, shelf beds, 8 to 10 inches deep, may be used (Fig. 4). In the case of a cool cellar, a warm shed or a tunnel being given up altogether to mushrooms, it is not uncommon to spread the bed all over the floor, as shown in Fig. 5, with a path one board wide raised above the bed as shown in the engraving. A cave or tunnel is practically the same as a cellar, except that these are seldom artificially heated. For this reason the beds are seldom on raised shelves, but are nearly always built on the floor. With beds built in this way and a good dry bottom, caves or tunnels make excellent places in which to grow the crop. Special mushroom houses may be constructed, but they need not concern us here.

FIG. 1.—ENGLISH OR BRICK SPAWN.

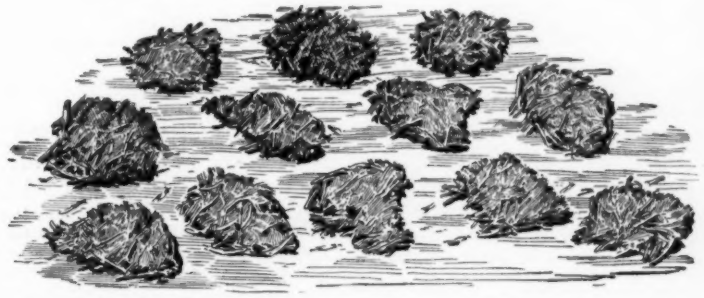


FIG. 2.—FLAKE BROKEN INTO PIECES READY FOR PLANTING.

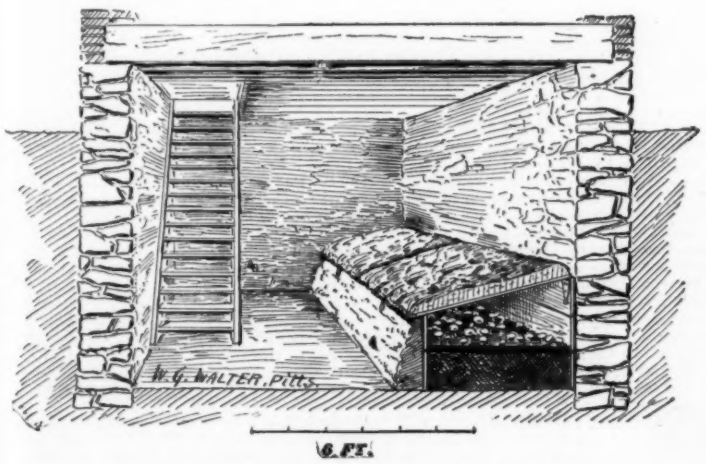


FIG. 3.—MUSHROOM BED IN COOL CELLAR.

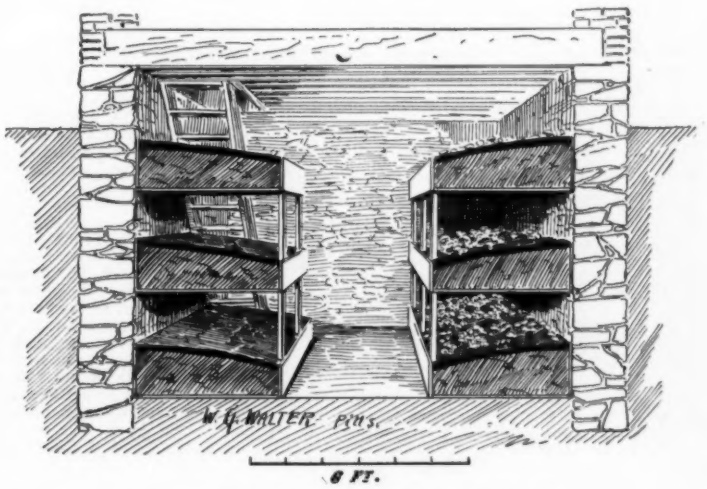


FIG. 4.—SHELF BEDS IN WARM CELLAR.

The best fertilizer for mushrooms is fresh horse manure, which should be short and strawy and well trampled and wetted in the stable. Throw it into a heap, wet it well if it is at all dry, and let it heat. When it begins to steam turn it over and shake it well, so as to mix thoroughly and evenly, then trample it down solid. After this let it stand again until it gets quite warm, then turn, shake, trample as before and add water freely if it gets dry. Repeat this turning, moistening, and trampling as often as it is needful to keep the manure from "burning." If it gets intensely hot, spread it ont to cool, after which throw it together. After being turned in this way several times, and the heat in it is not apt to rise above 130° Fah., it should be ready to make up into beds. By adding to the manure at the second or third turning one-fourth or one-fifth of its bulk of loam, the tendency to intense heat is lessened and its usefulness is not at all impaired.

If the beds are to be made on the floor, the latter should be dry. If the house or cellar is cool and unheated, the beds should be 14 to 16 inches deep. If heated, a depth of 12 inches would answer, but 14 inches is better. Measure off the floor space in long strips; these should be 3 or 4 feet wide at the sides and 4, 5, or 6 feet wide in the middle. The spaces should be 2 or $2\frac{1}{2}$ feet wide for pathways between the beds. If there are to be shelf beds over the bottom beds, the pathways should be $2\frac{1}{2}$ to 3 feet wide to permit of wheeling a barrow, as this will be necessary in taking the manure in and out. In the bottom of the beds place a 6-inch layer of well moistened hot manure from the ordinary stable pile and trample it until it is firm. In a few days after, when it has cooled off somewhat, fill up the bed with the manure specially prepared for the mushrooms, shaking it on in layers 1 or 2 inches thick, and trample down firm. If there is a proba-

bility of its heating intensely, put on only one or two layers a day, strew some loam between them, and raise the manure a little with the fork so that the earth may sift down through it. When the bed is made up, strew a little straw or hay over it to arrest the moisture from the condensed steam. If this is not done, the surface of the bed is apt to get rather wet. The straw should be left on until the bed is ready for spawning, after which it should be removed.

Ordinarily the beds are only 8 to 10 inches deep; that is, they are faced with 10-inch wide hemlock boards and are only the depth of this board. In such beds, put in a layer of fresh, moist, hot manure and trample it down firm until it constitutes half the depth of the bed; then fill up with the prepared manure, which should be rather cool (100° to 115° F.) when used, and pack all firm. If desired, the beds can be made up entirely of the prepared manure. Shelf beds are usually 9 inches deep; that is, the shelf is bottomed with 1-inch boards and faced with 10-inch wide boards. This allows about 8 inches for manure and 1 inch, rising to 2 inches, of loam on top. In filling the shelf beds, the bottom half may be of fresh, moist or wettish, hot manure, packed down solid, and the top half of rather cool prepared manure, or it may be made up of all prepared manure. As the shelf beds cannot be trodden and cannot be beaten very firm with the back of the fork, a brick is used in addition to the fork.

SPAWNING THE BEDS.

The beds should be spawned after the heat in them has fallen below 100° F. The writer considers 90° F. about the best temperature for spawning. If the beds have been covered with hay, straw, litter, or mats, these should be removed. Break each brick into twelve or fifteen pieces, as shown in Fig. 2. The rows should be say 1 foot apart, the first one being 6 inches from the edge, and the pieces should be 9 inches apart in the row. Commencing with the first row, lift up each piece, raise 2 to 3 inches of the manure with the hand, and into this hole place the piece, covering over tight with the manure. When the entire bed is spawned, pack the surface all over. It is well to cover the beds again with straw, hay, or mats to keep the surface equally moist. The flake spawn is planted in the same way as the brick spawn, only not quite so deep.

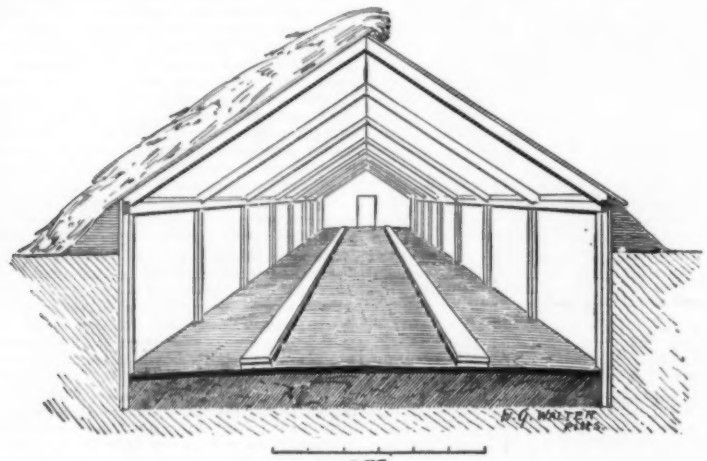


FIG. 5.—BOARD BED ON FLOOR OF CELLAR OR SHED.

LOAMING THE BEDS.

At the end of eight or nine days the mulching should be removed and the beds covered with a layer of good loam 2 inches thick, so that the mushrooms can come up in and through it. This gives them a firm hold and to a large extent improves their quality and texture. Any fair loam will do. That from an ordinary field, wayside, or garden is generally used, and it answers admirably. There exists an idea that garden soil surfeited with old manure is unfit for mushroom beds because it is apt to produce spurious fungi. This, however, is not the case. In fact, it is the earth most commonly used. For moulding the beds the loam should be rather fine, free, and mellow, so that it can be easily and evenly spread and compacted firmly into the manure.

TEMPERATURE.

An atmospheric temperature of 55° F. brings fine, solid, short stemmed mushrooms, and in this temperature the beds bear longer. A temperature of 60° F. is good. It brings the crop in a little earlier than 50° F., but exhausts it sooner. A temperature of 65° F. is too warm. Although mushrooms appear to thrive in it, they are rather thin, drawn, and short lived. Fifty degrees will do, but the crop in this temperature is slow in bearing. If the temperature in the cellar or mushroom house is apt to run higher than 60° F., some means must be devised for keeping it reduced. Should it fall below 50° F., it must be raised artificially, either by covering the beds or by heating the place they are in by hot water, steam, or a stove. Between the time of spawning and the first appearance of the mushrooms a temperature of 65° or 70° F. may be maintained with beneficial effects in causing the spawn to spread, but after the crop appears the heat should never be allowed to go higher than 55° to 60° F.

If an even atmospheric temperature of from 55° to 60° F. can be maintained, and the house or cellar containing the mushroom beds is kept close and free from draughts, the beds may be left uncovered and should be watered if they become dry. But, no matter where the beds are situated, it is well to lay some loose hay or straw or some old matting or carpet over them to keep them moist. The covering, however, as before stated, should be removed just as soon as the young mushrooms begin to appear above ground. If the atmosphere is dry, the pathways and walls should be sprinkled with water. The mulching should also be sprinkled, but not enough to cause the water to soak into the bed. However, if the bed should get dry, do not hesitate to water it.

GATHERING THE MUSHROOMS.

Go over the beds every day, and, if there are many beds, twice a day, and pick every mushroom that is large enough for market. Lay them in a single layer in trays, flats, or baskets, then take them outside to a cool shed or room. In picking do not cut the mushroom off at the root, but catch it by the top and give it a gentle twist or bend and it will come away from the ground quite easily. In this way no butts are left in the ground to rot and transmit disease to other mushrooms.

It sometimes happens that the mushrooms come up in solid cakes of about five, ten, or perhaps as many as fifty. To twist a few out of the clump would unfasten it and completely stop the further growth of those remaining. In such cases the mushrooms must be cut at the base, and a few days later, or just as soon as the clumps are gathered, the butt ends should be rooted out and the hole filled with a little fresh loam. In gathering never pile the mushrooms one on top of the other, because the dirt from the butt ends is apt to fall on the tops and give them a soiled appearance, and if the caps are burst open and the dirt falls in among the gills, it spoils the mushrooms and lowers the standard of the brand.

Do not delay gathering mature mushrooms until others have reached this stage, but whenever one is large enough pick it. If allowed to remain longer or until a few more are ready to pick, it will burst open, and that means deterioration in quality and appearance. If picked young and kept cool, dry, dark, and close, mushrooms will remain pretty, plump, and white for two days.

SORTING.

In gathering mushrooms everyone that is big or old enough, whether good, bad, or indifferent, should be taken, for to leave them longer would be to spoil the bed. In sorting these for market, however, take only those which are good and throw away the remainder. Never send a poor, old, small, drawn, or wormy mushroom to market. Where a grower makes a practice of putting in his baskets only first-class mushrooms, and putting them up firmly, neatly, tastefully, and cleanly, he will have no difficulty in disposing of them. His commission agent, knowing the character of his baskets and having perfect confidence in his honesty, will ship them to the first order. It will not be necessary in such cases for him to open the baskets to know what is in them. This saves him trouble, time, and expense, and he can guarantee satisfaction to his customers. On the contrary, where a grower puts all kinds of mushrooms in his basket—big and little, good, solid, white-headed ones, and flat, open, black-gilled ones, those with long, thin stems, and those with ugly, gouty ones—the commission agent has to sort them over and will keep and pay only for what is good. Moreover, as mushrooms will not bear much handling without considerable breakage and discoloration, and hence deterioration, it is far better and more profitable for the grower to sort them at home.

Having sorted the mushrooms, that is, thrown out everything that is worthless, they should be again looked over before packing. If the stems are long, shorten them half their length; if medium, cut off the butt ends; and if very stocky and short stemmed, rub the butts over so as to clean them perfectly from dirt or discoloration. Brush off any earth, straw, dirt of any kind, or flies that may have stuck to the caps. Now line the boxes or baskets with clean, white, cheap paper, and lay the mushrooms in gently and compactly. One, three, or five pound baskets, if long or wide rather than deep, may be filled up solidly and covered with white paper, and then all covered over with manila paper. These baskets can be shipped singly or in crates to the commission agents, and by them, without disturbing the contents, to their customers. The sizes of baskets mentioned are the most convenient for sending to private customers.

In 1897 a large commission house stated that the demand for mushrooms was increasing every year. The prices vary according to the supply and demand and according to the quality of the mushrooms. The finest quality of mushrooms that come to the market sell for 50 cents a pound. The inferior mushrooms sell for 40 cents, 30 cents, and even as low as 10 cents a pound. They recommend that none but the best mushrooms be shipped, as poor ones are a drug on the market, even when the best are in demand. They also advise growers never to ship any that are old. Mushrooms shrink almost more than anything else handled by the dealer. In warm weather they have been known in a seven-pound basket to shrink a half or three-quarters of a pound from the time they were shipped Saturday until they were put on the market Monday morning. The baskets should be lined with newspapers and the top covered with manila paper. Mushrooms stand a great deal of cold and they are never frozen so badly that they are unsalable. A string should be tied over the handle of the basket in such a way that other express packages cannot be placed on top of it so as to crush the mushrooms.

The interesting pamphlet of Mr. Falconer also contains advice regarding the marketing of the mushrooms, renovating of failing beds, mushroom diseases, insects, and other animal enemies.

SUPERSTITIONS ABOUT IRON.

IN Egypt iron was nominally accursed, even when people used it all day long and every day. It was "the impure metal"—"the bones of Typhon," father of evil. No man could touch it without sin; he must do penance and make atonement. That was the theory as long as the Egyptian race endured; in practice iron had been handled freely for several thousand years. The only piece of metal found in the Great Pyramid was an iron bar. The same conflict of ancient faith with growing convenience was urged everywhere, no doubt; but the record does not exist. It was lost before the classic time, and so Greek and Roman sages puzzled over odd little customs handed down from days of old. Cicero asked in vain why a tool of iron must not be brought into the sacred grove of the Arvals—or, if brought by accident, must be expiated by the sacrifice of a pig or a lamb; and Plutarch wondered why the Archon of Platæa might not touch iron except at the yearly festival commemorating the triumph of Greece. There is no end to such instances. The sacred old Pons Sublicius had to be repaired without using iron; so had the ancient temple of Jupiter Liber. In imperial times, when the meaning of such rules was lost, a special law abrogated them.

One may survey mankind from China to Peru and find the same superstition everywhere. Iron tools were forbidden in the building of the Temple at Jerusalem; the late Rajah Vizanagram, a member of the council, a man of great learning and enlightenment, would not allow iron to be used in any building throughout his territory. He believed that an epidemic would follow. Negroes of the Gold Coast must remove any articles of iron on their persons when consulting the Fetish. Upon the other hand, a Sikh must always have a piece of steel or iron about him. Burton tells how "the pious Moslem stretches out a finger, exclaiming, 'Iron! oh, thou ill-omened one!'" when a dust storm approaches the caravan—believing it to be directed by a Djinn.

In Scotland many traces survive. To use iron in kindling the "needfire" was awful impiety. When a fisherman swears during bad weather at sea his comrades still grasp the nearest bit of metal, crying "Cauld iron." It is not so long since people thrust a nail or a knitting needle through each article of food in the house, or dipped it in the liquor, when a person died. This is enough—persons interested in the subject will find reams of evidence in books devoted to folk-lore. We may credit that the superstition arose everywhere at the time when fierce invaders, armed with iron, overran the country, massacring the helpless people and destroying the antique religion. It was the accursed metal. Afterward, by a natural process, the evil thing often came to be regarded as a protection against other evil things—witches and demons and charms and death itself. English babies were defended from fairy kidnappers by putting a key, knife, pair of tongs, above all, scissors, in the cradle. In many of those pretty tales dealing with a "swan maiden," the girl cannot recover her plumage because it is locked in a chest with an iron key—sometimes she gets a mortal to open the chest, and flies away upon the instant. In other stories she is released by a touch of iron; in one favorite version, by the husband throwing his bridle at or to her—the iron bit is fatal.—London Standard.

The following requirements for steel for fire-boxes are specified by the Railway Master Mechanics' Association of America: Test samples should show a tensile strength of 60,000 lb. per square inch and an elongation of 28 per cent. in 8 inches. Sheets will be rejected which show a tensile strength of less than 55,000 lb. or more than 65,000 lb. per square inch, or an elongation less than 22 per cent. in 8 inches. Sheets will be subjected to chemical analysis. The following is the chemical analysis required:

			Desired.
Carbon	not over 0·25 nor under 0·15		0·18
Phosphorus	" "	0·035	0·03
Manganese	" "	0·45	0·40
Sulphur	" "	0·035	0·02
Silicon	" "	0·03	0·02

Sheets will be rejected which show a seam or cavity more than ¼ inch long in either of the three fractures obtained in the following homogeneity test: A portion of a broken test piece is either nicked with a chisel or grooved on a machine, transversely to the depth of about a sixteenth of an inch, in three places about an inch apart, alternately on opposite sides. The test piece is then held firmly in a vise, with the first groove about a quarter of an inch above the jaws, and the projecting end broken off by a number of slight blows from a hammer, bending it away from the grooved side. The piece is broken at the other grooves in the same way.—The Engineer.

An application of the megaphone to the work of railway switching and signaling has been made at the Greensburg, Ind., tower of the Big Four road. The plant was recently installed with 60 levers, and some of the switches are 1,800 feet from the tower. In switching work it is sometimes very convenient for the operator in the tower to be able to speak to the switching crew, and to increase the distance over which such communication can be had the megaphone has been introduced at the point named. It is also being used in one of the railway yards at Boston, and it is said that in both places the device is found to be serviceable and its use very satisfactory.

ENGINEERING NOTES.

Russia is going to turn the harbor of Libau, on the Baltic, near Riga, into a first-class naval station and fortress. The port will be closed to merchantmen and foreigners, for whom the harbor of Windau is being fitted up.

As the result of a series of experiments on brasses containing various percentages of bismuth, Mr. Sperry, of Bridgeport, Conn., has arrived at the following conclusions; 1. Bismuth renders brass cold short, and is similar in this respect to antimony, although the effect is not as marked; 2, bismuth is a cause of fire cracks in brass; 5, high brass intended for cold rolling should not contain over 0·01 per cent. of bismuth; 4, bismuth produces hot shortness in brass; 5, bismuth is a cause of latent fire cracks in brass.

Messrs. Lane & Bodley, of Cincinnati, give particulars of large machine tools which they have laid down in their new works. One of these will be a big planer, which will be 16 feet by 16 feet by 56 feet in its working parts, 112 feet long and 32 feet high. The largest boring machine in the world will be set up in the new plant, having a diameter of 32 feet, a swing of 32 feet by 16 feet, and being 32 feet high. The third world's record breaker will be the hydraulic press, which will have a nominal capacity of 500 tons, and be capable of 1,000 tons. It will have a 4-foot stroke and be 38 feet long. The key seating machine will cut a key seat in a wheel hub 5 inches wide, 4 feet long.

Of the discovery of many inventions there is no end. But there is one most practical utensil which is very much wanted, says The Syren, namely, a weighing machine which will automatically weigh coal as it is being put into the bunkers. When coal costs from $5 a ton upward, it becomes a commodity of monetary value sufficient to make it worth while weighing. The plans in vogue at foreign coaling stations at present are either measuring the lighters or weighing a few bags—usually selected with care by suppliers—and counting the bags when empty. Neither method is satisfactory, as there may be gaps in the lighter or it may not be square, and bags are at times smuggled aboard empty. What is wanted is a tub which would empty itself when a ton of coal had been put into it, and register the number of tons—although this latter is not essential, as the tons could in the way suggested be tallied.

It is stated that the British government has just given an unprecedented order for a new 6-inch wire gun, with Vickers' new breech-loading mechanism. The order is for 200 guns, 90 to be made at Woolwich, 60 by Vickers, Son & Maxim, and 50 by Sir William Armstrong, Whitworth & Company. Large orders for shell for these and other guns have been given to Messrs. Hadfield, of Sheffield, whose works at the present time are nearly wholly employed in manufacturing projectiles for the British government. The above orders are said to be necessitated by the change of armaments and the strengthening of the coast defenses. Much activity prevails at Woolwich Arsenal and Dockyard. At the latter establishment workmen have been employed as late as eleven at night dispatching search lights for the naval squadron which is to assemble at Plymouth.

The shells used by the United States navy, the guns for firing them, and the powder charges in each case, are given in the following table:

Designation.	Shells. Diameter. Inches.	Weight. Pounds	Len'th in Inches	Charge Contained, Pounds.	Guns. Weig't lb.-tons.	Lgth in Feet.	Firing Chge Lb.	Total Cost of Firing Once.
1-pdr..	1⅜	1	3⅝	200*	100	5	..	$1.12
3-pdr..	1⅞	3	6½	900*	500	7	..	. . .
6-pdr..	2 1/16	6	8⅝	1,400*	920	9	..	5.70
4-in. ..	4	33	12¼	2	1½	14	14	.....
5-in. ..	5	50	16¾	3	3½	17	30	33.00
6-in. ..	6	100	20¾	4½	6	21	50	40.00
8-in. ..	8	250	22⅜	11	15	29	115	65.00
10-in. ..	10	500	30	20	28	31	240	.....
12-in. ..	12	850	36	40	45	37	425	. . .
13-in. ..	13	1,100	42	50	60	40	550	296.00

* Grains.

Note.—For 13-inch armor-piercing projectiles, the total cost of firing is $588.

—Engineering News.

It has often been noticed that the combustion of anthracite in the furnaces of steam boilers brings about the more or less rapid destruction of wrought iron tubes, owing to the action of the salts deposited upon them; and this tendency to the deposit of a saline substance varies with the nature and source of the anthracite—observes the Eisen Zeitung—being considerable in that from the Kohlscheid district of the Wurm coalfield, near Aachen, while British anthracite of good quality is much freer from this defect. With the object of ascertaining how this difficulty may be counteracted, trials were made of wrought iron tubes variously coated, and also with brass tubes like those of locomotives; but, after a continuous trial of five months it was found that the coated iron tubes gave no better results than those uncoated. Galvanized wrought iron tubes appeared sound outside, but when they were examined inside it was found that the zinc had been dissolved, so that on the salt crust being removed the bare iron appeared. It therefore became evident that galvanized tubes would soon become as defective as the ungalvanized, and inasmuch as they cost twice as much as ordinary wrought iron tubes, they can only be economical if they last more than twice as long. Brass tubes were also attacked inside, but to a slighter extent, and they may be considered to last a certain number of years before requiring renewal. It appears from the foregoing that brass is the best metal for flue tubes, when anthracite is burnt on the grate; but its first cost constitutes a drawback, and experiments are now being made with both nickel and aluminum tubes for furnaces fired with anthracite.

ELECTRICAL NOTES.

The London Electrician describes measurements carried on by Siemens & Halske to determine the resistance of the bodies of a large number of workmen. Between the hands values ranging from 900 to 2,000 ohms were obtained, and between the hand and earth—the men wearing the wooden shoes of German workmen—resistance ran from 14,000 to over 150,000.

"We have already noted," says Cosmos, "the use of fence wires on the Australian plains as telephone conductors. According to The Australian Agriculturist, this use is becoming general, and the farmers thus commonly communicate over distances of 12 to 20 kilometers [7½ to 12½ miles] . . . Unfortunately, the wires conduct lightning as well as the feeble telephonic currents, and animals that take refuge against the fences are often killed by a stroke that reached the earth at some distant point and was conducted to them by the fence."

A thoughtful American inventor has just brought out an electric walking cane lamp, which may prove useful to some folks in the small hours. The handle of the cane contains an incandescent lamp, the two poles of which are connected with the plates of a battery. Below this is a small chamber to carry the battery fluid. When it is desired to use the lamp the cap is taken off and the cane inclined so that the liquid it contains comes in contact with the electrodes. A current is thus produced that will, it is asserted, keep the light going for an hour, which ought to be a sufficient allowance of time for the sometimes somewhat difficult search for the keyhole, provided the lamp works.

Mr. O. Brathuhn, in an article on underground surveying in the Berg und Huttenmannische Zeitung for 1898, states that in plumbing a shaft 390 feet deep with an iron plumb bob he found a considerable error. The explanation lay in a cross cut from the shaft in which a large number of spare rails had been stored with one end of the pile very close to the plumb line. He says that by the induced magnetism of the rails the plumb line was drawn from its perpendicular position to such an extent that the bottoms of two lines were 7·5 mm. further apart than the tops of the same lines, and the line connecting the plumb lines at the points of suspension formed an angle of 6 feet with that at the bottom of the shaft. The trouble was corrected by using brass plumb bobs.

The New York Fire Department is to have a telephone system as complete as its telegraph service in future, says The New York Tribune. Every fire-alarm box will be a telephone station, and, instead of telegraph signals, for second and third fire alarms and ambulance calls, verbal messages to fire headquarters will suffice.

The change is the idea of Superintendent H. S. Blackwell, of the fire-alarm telegraph bureau of the department. He proposes to use the regular fire-alarm boxes and the present circuits for the new system. Each box will be altered to receive a telephone plug, and this is all that will be necessary so far as the boxes are concerned. Each chief in the department will carry in his wagon a case about 3½ inches by 5 inches, in which will be kept a receiver, a transmitter, an induction coil, and a battery. When the chief reaches a fire in future, and finds that another signal is necessary, he will step to the box, open the inner door, insert the telephone plug, and the operator in fire headquarters will instantly be in direct telephonic communication with the man in command of the fire.

Electric traction on New York street railways is rapidly growing. According to a late article in The Street Railway Journal, nearly four-tenths of the entire metropolitan system of lines was operated by electricity on September 30, 1898. In the year ending June 30, 1898, about 34¼ per cent. of these lines employed cable traction, 20½ per cent. underground electricity, and 45½ per cent. horse power. Reducing the earnings and expenses to the mile basis, the following comparison per car mile is made:

	Gross Earnings. Cents.	Total Expenses. Cents.	Net Earnings. Cents.
Cable lines.....	34·42	16·42	18·00
Electric lines	27·00	10·25	16·75
Horse traction.....	27·35	17·87	9·50

While the electric lines thus show a less total expense for operation and maintenance than either cable or horse car, the writer says that this statement may be somewhat misleading, owing to the fact that the electric lines are practically new, and cost for maintenance is only ¼ cent per car mile, as compared with 3½ cents on the cable lines and ¾ cent on the horse-car lines. But the article also claims that the experience in New York demonstrates that the underground electric is better than cables in the large cities when traffic is dense and weather conditions favorable.

It is announced at Marquette, Mich., that experiments will be conducted by the government at that point in the use of electricity in lighthouses, says The Western Electrician. A submarine cable has been shipped to the local electric light and power company, and it will be laid to the lighthouse on the extreme end of the breakwater in the lower harbor. The lantern in the lighthouse will be fitted with a concentrated-filament stereopticon incandescent light of 50 candle power, five times the candle power of the kerosene light which is now in use. But the increase in brilliancy is a secondary object. In the spring and fall gales waves frequently sweep the breakwater from end to end; and it is a matter of much peril for a man to traverse 3,000 feet of breakwater in order to light the lamp. With an electric light in the lantern the current can be turned on from the shore, and, no matter how fierce the storm, there need never be a fear but that the lamp will be found burning brightly. The first 1,000 feet of the breakwater is capped with a concrete superstructure which has a tunnel running through it. That far the cable will pass through the tunnel and be thoroughly embedded in cement. For the remaining 2,000 feet, which is not capped by a superstructure, the cable will pass over the top of the breakwater, being held in its place by cleats. It is this part of the course which necessitates the use of a submarine cable, because heavy seas constantly break over it in storms.

SELECTED FORMULÆ.

A simple fire extinguisher may be made by any one at small cost, by dissolving two pounds of common salt and ten pounds of ammonium chloride in three quarts of water and filling the solution into quart bottles of thin glass. This mixture has been found very suitable for extinguishing small fires. The bottles must be tightly corked and sealed, to prevent evaporation. At the breaking out of a fire, the bottles are thrown into the flames or their vicinity, and the extinction is effected by the contents of the breaking bottles. —Südd. Ap. Ztg.

Odorless Butter Coloring.—The following is accounted a formula that yields a satisfactory odorless butter coloring:

Annatto	½ ounce.
Sodium bicarbonate.....	4½ "
Sugar	8 "
Potassium nitrate.....	8 "

Soften the annatto with about 2 ounces of water, using the heat of a water bath; stir in about 2 ounces of the sodium bicarbonate, evaporate to dryness and mix with the remainder of the soda and the other ingredients.

MacEwan, in his "Pharmaceutical Formulas," states that vegetable annatto is being replaced by aniline orange, the following being recommended as a popular coloring:

Oil soluble aniline orange	1 ounce.
Olive oil.....	160 fluid ounces.

Dissolve the color in the oil by gentle warming. Cotton-seed oil may be used in place of olive oil. A teaspoonful of the coloring is sufficient for 10 gallons of cream.—American Druggist.

Photo Paste.—Pastes that liquefy on working up or heating usually consist of a jelly of isinglass or refined gelatin. The most satisfactory paste for use as a photograph mountant has the following composition:

White dextrin	8 ounces.
Water, heated about 160 deg. F..	12½ fl. ounces.
Oil wintergreen.....	3 drops.
Oil cloves	3 "

Dissolve the dextrin in the hot water by stirring, and when cool, add the oils and stir until a smooth cream results. Pour the paste in suitable vessels, glass wide-mouth bottles or porcelain jars; cork and place in a cool place for about one week to allow the paste to congeal and ripen.

The following formula yields a very satisfactory gelatin paste, and is especially recommended for mounting photographs:

Best refined gelatin	4 ounces.
Water.....	16 fluid ounces.

Soak, dissolve on a water bath, and add when somewhat cooled:

Glycerin.....	1 fluid ounce.
Alcohol.....	5 " "

—American Druggist.

Transferring Pictures to Glass.—1. First coat the glass with dammar varnish or else with Canada balsam mixed with an equal volume of oil of turpentine, and let it dry until it is very sticky, which takes half a day or more. The picture or printed paper to be transferred should be well soaked in soft water and carefully laid upon the printed glass, after removing surplus water with blotting paper and pressing upon it, so that no air bubbles or drops of water are seen underneath. The picture should then dry a whole day before it is touched: then with wetted fingers begin to rub off the paper at the back. If this be skillfully done, almost the whole of the paper can be removed, leaving simply the ink upon the varnish. When the paper has been removed, another coat of varnish will serve to make the whole more transparent. 2. Any picture, print, or even clipping from newspapers, any engraving, no matter in how many colors, or on what kind of paper, may be transferred to glass, only the treatment of the different kinds of paper differs. Proceed in the following manner: Place the object to be transferred, face downward, upon a large sheet of manila paper; prepare a solution of from 1 to 3 per cent. of nitric acid in water, according to thickness and strength of paper, and how strong it was sized; ordinary newspapers and printings or engravings on unsized glazed paper require even less than 1 per cent. nitric acid—one of the purposes of adding nitric acid is to remove the sizing out of the paper. This solution apply with a sponge to the back of the object to be transferred; be careful not to overdo it; you only want to render the paper soft but not wet. Continue sponging with this solution until you see the printing plainly; that is, until the paper becomes quite transparent.

To prepare the glass for transferring, proceed as follows: Clean the glass plate thoroughly with alcohol by means of a ball of clean cotton; dry it off well; wash it with turpentine; dry it off again; place the glass plate upon a smooth elastic layer—for instance, flannel—and with this elastic layer upon a table, or, better yet, upon a rubber blanket in the litho hand press. Now coat the cleaned surface with a thin coat of half turpentine and half dammar varnish; let it dry from ten minutes to one day, according to temperature and thickness of dammar varnish. The coating should not be allowed to dry entirely; it should be a trifle adhesive. Lay your impression face downward upon the glass plate; it is important that neither acid nor water touches the surface during the entire process. Be careful to avoid air bubbles.

Press the sheet to the adhesive dammar coat. This may be done in many different manners. It does not require a very strong pressure, but it should be observed that each and every spot has to be pressed repeatedly against the plate. When the paper sticks quite smoothly to the plate, fan it perfectly dry, and then, with wet finger tips, slowly rub off the paper; the print, of whatever color or nature it may be, will remain on the glass plate. Upon this apply another coat of dammar varnish containing very little turpentine. With too much turpentine, you run the risk of washing the entire picture from the plate again.—Pharmaceutical Era.

"THE MONUMENT TO THE DEAD."

ON All Saints day, which is so religiously kept by the Parisians, the crowd that was surging on toward Pere-Lachaise stopped on its way before the high palisades surrounding the ground where but recently stood the broken column consecrated, in all our cemeteries, to the memory of the departed whose sepulture is no longer marked by any prayer or cross. And the curious, after a short halt, made their way forward, disappointed at not having been able even to look through the tight fence behind which something is in the course of erection. This "something" they will have learned, either from the watchmen or from some of those well informed people that one never fails to meet with in a crowd, is Bartholomé's "Monument to the Dead."

There has already been, more than once, a question of this monument, which has been in course of execution for several years; and the public has had an opportunity of appreciating some remarkable portions of it at the annual Salons. We are now able to present to our readers an engraving that will permit them to judge of this masterly work as a whole.

It has the form of a vast mausoleum in the center of which opens the door of unfathomable mystery, across the threshold of which a couple of persons have passed. On each side, Humanity, symbolized by beautiful and sorrowful figures in high relief, sighs, weeps, and trembles, each individual reflecting upon the words of the Scriptures, Memento quia pulvis est, and upon the fact that his turn will certainly come to enter this dread door. But another symbol, a consolatory one, detaches itself from the base of the mausoleum.

BARTHOLOMÉ'S "MONUMENT TO THE DEAD," IN THE CEMETERY OF PÈRE-LACHAISE.

Above a husband and wife lying in the icy tomb, where they seem to be sleeping an eternal sleep, a female with a face full of serenity extends her arms, while the following inscription translates into precise terms the eloquence of her gesture: "Upon those who inhabit the country of the shadow of death a light shines," the light of immortality.

It is superfluous to comment further upon the essentially spiritualistic idea of the eminent sculptor. It has haunted many artists before him; but it is difficult to interpret it under a concrete form without the risk of throwing in commonplace allegory. M. Bartholomé will have had the rare merit of avoiding this dangerous shoal, by conceiving a work bearing the imprint both of great nobility and powerful originality. The execution, moreover, is on a level with the conception.

For the above details and the engraving, we are indebted to L'Illustration.

ROENTGEN RAYS.

By W. C. ROENTGEN.

IF an opaque plate be arranged between the vacuum tube and a platinocyanide-barium screen, even pretty close to it, there is some fluorescence, which is cut off when the air situated laterally is sheltered from the impact of Roentgen rays by a thickness of lead. The effect is not due to the bending of rays; but the air, when struck by the rays, sends out Roentgen rays in all directions; so that if our eyes were sensitive to these rays, a vacuum tube would appear like a lamp in a room filled with tobacco smoke, and possibly the light from the tube and that from the air would have different colors, though there are at present no means of testing this question (whether the air acts by simple diffused reflection or as a quasi-fluorescent substance), for the rays from the air are also photographically active.

For comparative measurements the author uses a simple vertical plate of lead along the mid-line of a table; the fluorescent screen is placed at right angles to this, so that half the screen looks toward the left and half toward the right side of this partition. The two tubes to be compared are placed one on each side of this partition, and each then affects only one half of the screen. In using this it is found that the tubes are very inconstant; they are sensitive to irregularities in the make and break (worse with Foucault's than with Deprez's contact breaker); and when the outbursts of Roentgen radiation follow one another so rapidly that the eye cannot detect any want of continuity in the phosphorescence on the screen, the brightness of the screen depends on the intensity of the radiation from the platinum plate of the discharge tube, on the kind of rays reaching the screen, on the distance between the screen and the tube, on the absorption undergone by the rays before reaching the screen, on the number of discharges per second, on the phosphorescent afterglow of the screen, and on the radiation to the screen from surrounding objects. From a flat plate the radiation is equal in all directions up to about 80° from the normal, and the difference is only well marked at between 89° and 90°. The mode of experiment consisted in flexible photographic films bent to a half circle half surrounding the source; there is no ascertainable difference between the radiations at different angles; the photographic effect increases, except in extreme cases, with the angle between the source of rays and the photographic plate. There is an analogous case of equality in all directions in optical fluorescence. Drop fluorescein into water in a square tank illuminated by white or violet light, and the walls of the columns of fluorescein solution appear the brightest, i. e., where the angle of emanation of the phosphorescence light is the greatest. Stokes has explained this through the fluorescence light being much less absorbed by the fluorescein solution than the exciting rays are. So here, the exciting cathode rays are much more absorbed by platinum than the induced Roentgen rays.

The sharpest shadows are obtained by tilting the platinum away from parallelism with the photographic plate through not more than 80°; and the impression is then the most intense. In the absence of disturbing effect from the air, and on condition that the radiations remain of the same kind, the brightness of a fluorescent screen varies inversely as the square of its distance from the source.

Splitting a solid into layers makes no difference in its transparency; nor does putting it nearer to or farther from the screen. Rays which have traversed one thickness traverse another more readily (in proportion); so that the specific permeability (fraction of radiation let through a layer of unit thickness) is greater, the thicker the object. When two plates of different substances are equally permeable, this equality disappears if the plates are equally thickened or thinned; with plates of Pt 0·0026 mm. and of Al 0·0299 mm. thick, one Pt = six Al; but two Pt = sixteen Al. Other similar numbers are given for other tubes. The relations between the equivalent thicknesses of two substances vary with the thickness and the nature of the material (e. g., the walls of the vacuum tube) traversed by the rays before reaching the screen. The author uses a platinum foil, 0·0026 mm. thick, with fifteen holes in it, closed respectively by single, double, . . . fifteen fold thicknesses of aluminum, each of 0·0299 mm. thickness. When this is interposed, a glance shows which thickness of aluminum is equal to 0·0026 mm. of platinum.

The corresponding number of aluminum thicknesses is called the "window number," the apparatus being called a "platinum window." Example: With direct radiations the window number was 5; on interposing 2 mm. soda glass, the window number became 10; the rays filtered through the glass found it relatively easier than before to traverse the aluminum. Rays sent through this platinum window and then through a dozen photographic films indicated the window number 10 for the first film and 13 for the last.

Conversely, one and the same substance is differently permeable to rays from different tubes: lowest vacua, least potential of discharge, "softest" tubes, least power of penetration; highest vacua, highest potential of discharge; "hardest" tubes, greatest power of penetration. With the former, window number say 2; with the latter, may be beyond 15. With the former, simple shadows of the hand; with intermediate exhaustions, good bone shadows; with the last, bones also permeable. With one and the same tube the quality and penetrating power of the rays depend upon the action of the contact breaker (which fluctuates), the length of spark gap parallel to the tube in the secondary circuit, the introduction of a Tesla transformer, the amount of vacuum, and other uninvestigated changes within the tube itself. Putting a tube on the pump at the lowest sufficient vacuum, with small spark gap parallel to the tube, the tube is very "soft," the rays absorbable, and the window number small. Putting in a Tesla transformer, or a spark gap in series, the tube is "hardened." With a Tesla transformer in circuit, with narrow tube and wire electrodes, the rays are given off in air at 3·1 mm. Hg, and at still lower vacua in hydrogen.

The highest vacuum under which the rays can be given off is beyond 0·0002 mm. Hg. As the vacuum is increased, the spark gap must be at the same time lengthened; and when the tube is so "hard" that the spark gap has to be more than 20 cm. long, the rays will go through 4 cm. of iron. The tube will also become harder through its own continued action; so "hard" that a shadow photograph of a gunlock at 15 cm. distance can be taken in 12 minutes—a relatively long exposure, because the rays go through the photographic film instead of affecting it. This hardening is due to self-exhaustion, and to some change in the electrodes themselves.

A tube, if too hard, can be softened by letting in air, by warming it, by reversing the discharges, or by driving very powerful discharges through it. In the last case, the necessary potential of discharge becomes high, but the rays are very absorbable and the window numbers low. It appears that the kind of rays emitted depends on the mode of discharge, however this may be attained. The same mode of discharge would give the same Roentgen rays, even at relatively high pressures. The quality of the rays is not affected by the strength of the primary current, assuming that

the contact breaker acts equally at all current strengths; but their intensity is affected. Therefore, (1) the radiations from a tube are mixed, and differ in absorbability and intensity; (2) the composition of the mixture depends on the mode of discharge; (3) different rays are absorbed by different substances; (4) cathode rays resemble Roentgen rays in many respects, and the two discrepancies (*a*) difference of absorbability, and (*b*) the permeability to the two kinds of rays according to the density of the substance not following the same law, may be found bridged over by further researches leading to the discovery of rays of intermediate condition, say the Roentgen rays in ultra-soft tubes and extremely thin windows, or the cathode rays in ultra-hard tubes.

Photographic results follow the fluorescent screen pretty closely, particularly with soft tubes; but with hard tubes the window number seemed a little lower than with the screen. When a hard and a soft tube bring the two halves of the fluorescent screen to the same brightness, a photographic plate put in place of the screen is less affected by the rays from the hard tube; in the latter the rays go through the film, and will go through 96 films and impress the last one while the first is scarcely over-exposed. For this special reason, hard tubes require longer exposures; very soft tubes need longer exposures on account of their feebler intensity.

In a tube in action, Roentgen rays come not only from a minute area on the anticathode, but, more feebly, from the whole plate and a part of the walls of the tube. Cathode rays go in all directions from the cathode, but only feebly except along the axis. When the tube is hard and the platinum anticathode very thin, Roentgen rays start in considerable quantity from the back of the latter; and in very hard tubes the point which most emits Roentgen rays can be shifted away from the anticathode by a magnet.

Continued experiments show no difference in the permeability of any crystal according to the direction of the axis. It is the case that the eye can sometimes perceive the presence of Roentgen rays; this is due to the setting up of fluorescence in the retina; and with hard tubes, looked at through a narrow slit in a lead sheet, it is not difficult, by moving the slit, to get changing luminous figures. Nothing which may really be referred to diffraction has been discovered, though repeatedly sought for; apparent instances have all been found to be otherwise explicable.—Annal. Phys. Chem., 64, 1, pp. 18–37, 1898.

RAPID MOUNTING OF A LOCOMOTIVE.

EXPERIMENTS in the rapid mounting of locomotives are very advantageous, since they not only permit of ascertaining the amount of skill possessed by the workmen, but allow the foremen of the shops to find out what modifications ought to be introduced into the pieces in order to facilitate the mounting.

As long ago as the month of March, 1896, the French Company of the Railways of the East made a successful test of this kind in which a locomotive and tender were mounted in 107 hours. On this occasion it was perceived that it would be important to develop the use of templates and calipers, and deliver entirely finished pieces for the mounting, etc.

It is again this same company that has performed the work of which we desire to speak, upon a high speed freight engine. This engine, which was mounted in 66 hours in the shops of Epernay, is, however, of somewhat simple structure. It has three coupled wheels without a trailing axle. It is 32 feet in length and 9 feet in width outside the footboards, and weighs 9,420 pounds empty and 10,760 loaded. It is provided with two sand boxes and a Westinghouse brake. The suspension is somewhat complicated and there are neither water tanks nor coal bunkers. The boiler is 25 feet in length, with a mean diameter of 4¾ feet. It has two hundred and seventy-two 13 foot tubes.

These data, with the accompanying figures, will serve to show the importance of the work successfully accomplished in 66 hours.

The mounting was effected by an ordinary gang of workmen directed by M. Desbordes, and consisting of eleven mounters, four apprentices and one helper, although at times, when it was possible, supplementary men were pressed into service from neighboring gangs. The daily work was of 10 hours. All the parts of the locomotive were brought to the place of operations by a helper, and a 30 ton crane was almost constantly at the disposal of the workmen. The boring of holes was done by drills run by an electric motor. Of course, all the parts to be used were brought to the spot in a perfectly finished state.

On the first day the sole bars were put in position, the cylinders were mounted, and the squaring of the frames was verified. At the end of the twenty-fourth hour, or, in other words, at the beginning of the third day, the engine began to assume some little form. During the fourth day the engineman's cab was mounted, the boiler being already definitely in place between the sole bars. At the end of the forty-ninth hour, the workmen began upon what may be termed the details—the mounting of the air pump, the distributing movement, and the boxes upon the axle journals. At the end of the fifth day the engine rested upon its wheels and upon the track through which it was to leave the shop.

From this special view point, it must be said that it had been possible to gain a few hours. The placing upon wheels had been effected immediately upon the service and not upon the mounting track. In this way an extra handling of the locomotive was avoided. Although it now appeared to be ready for running, the engine nevertheless needed, among other important things, its connecting rods. On the seventh day the regulation of the distribution was verified, the engine was weighed, and the springs were regulated; the engine was fired up, the brake and its injectors were tested, and, at one o'clock in the afternoon, it was possible to make a trial trip as far as to Jalons-les-Vignes.

The number of hours during which the workmen of different specialties were employed were as follows: Mounters (inclusive of the foreman), 976 hours; apprentices, 264; helpers, 60; boiler plate workmen, 62; riveters, 126; boiler maker's apprentices, 42; and pipe fitters, 76.

This mechanical feat was facilitated by the simplicity of construction of the locomotive under consideration, but the fact must not be forgotten that the number of workmen employed was, upon the whole, not large. M. Desgeans, the engineer in charge of the construction, hopes, moreover, to do better yet at another time, by having many pieces finished in advance.

For the above particulars and the illustrations we are indebted to La Nature.

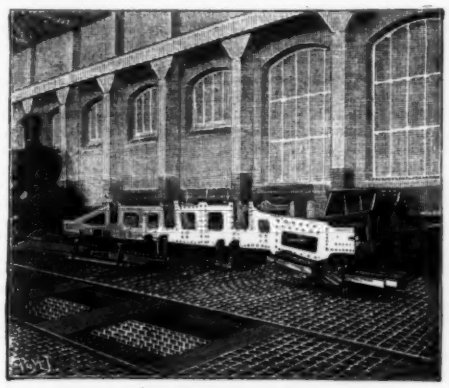


FIG. 1.—THE LOCOMOTIVE IN THE FIRST HOUR.

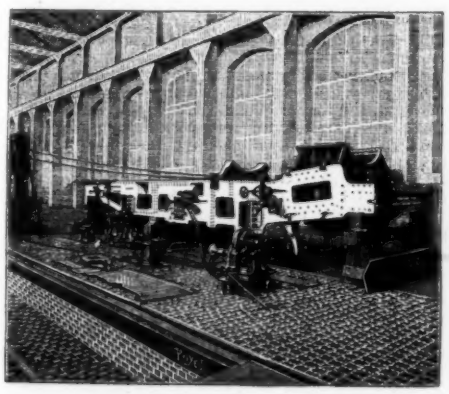


FIG. 2.—STATE OF THE WORK AT THE ELEVENTH HOUR.

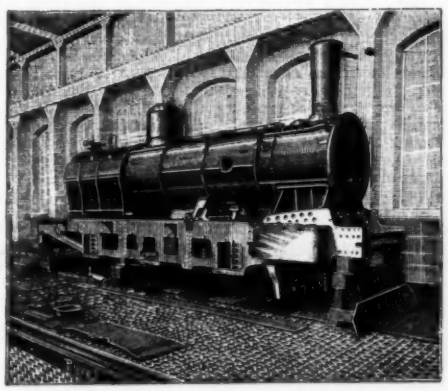


FIG. 3.—STATE OF THE WORK AT THE TWENTY-SECOND HOUR.

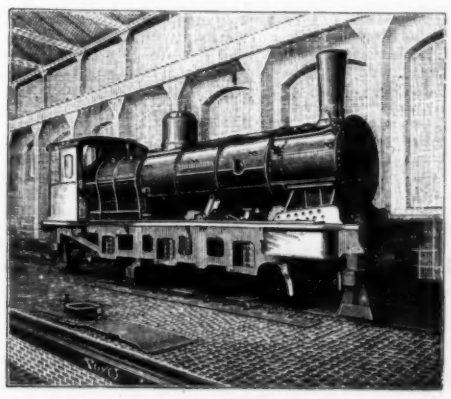


FIG. 4.—THE LOCOMOTIVE AT THE THIRTY-THIRD HOUR.

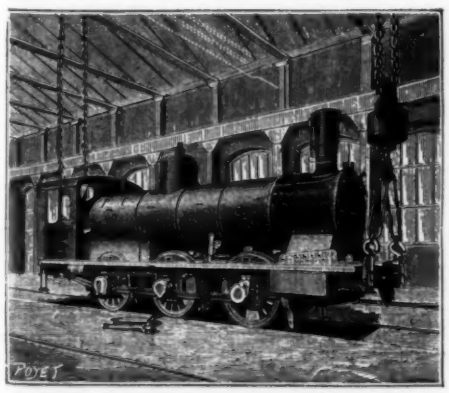


FIG. 5.—STATE OF THE WORK AT THE FORTY-NINTH HOUR.

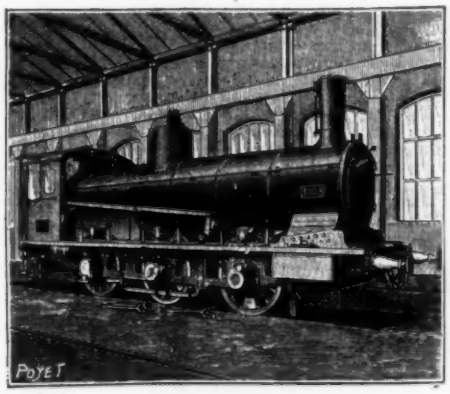


FIG. 6.—THE LOCOMOTIVE AT THE FIFTY-EIGHTH HOUR.

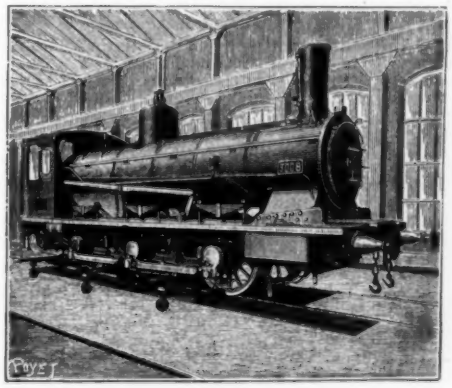


FIG. 7.—THE LOCOMOTIVE AT THE SIXTY-FOURTH HOUR.

THE ENGINEER AND HIS WORK.*

By CHARLES WALLACE HUNT.

THE duty which devolves upon me this evening was first entered into as a task, but it grew to be a pleasure, as the growth and importance of the functions of the engineer became evident on every side, as we study them in our national development, in our industries, and even in the comforts and the luxuries of our daily life.

Each one of us looks out upon the same world from a different standpoint, and each sees the same general scene, but the scope of the view and the details observed will vary to a greater or a less degree, depending upon our particular position. In addition to this, each, as it were, looks through a colored glass which gives a personal tint to the scene, colored by the effects of our environment, as well as by our personal temperament.

In order that we may proceed in harmony of thought, we must use words in the same sense. Let us, then, first consider what we mean by the word "engineer"—not what it meant historically, but what it has come to signify in the active world of to-day—and try to bring our individual conceptions of this meaning into harmony each with the other. Following Tredgold, I have herein used the word "engineer" in the broad sense of one who is skilled in the application of the materials and forces of nature to the uses of man.

Considered in this broad sense, the engineer is interested in every investigation and discovery in the whole realm of nature. Experience has shown that every field is tributary to his work. The theoretical abstraction of yesterday becomes a demonstration to-day, and to-morrow it is the task of the engineer to apply it to the uses of man. The new discoveries of materials, of forces, and of laws which now succeed each other so rapidly, make a corresponding increase in the range of the work and the responsibility of the engineer of this present day.

* Presidential address before the American Society of Mechanical Engineers, forming a part of vol. xx. of the Transactions.

ENGINEERING PRACTICE.

That we live in an age of changes is at once our opportunity and our pleasure. Some of these changes burst upon us, attracting universal notice, while others come so slowly that they are almost unobserved. A change of the latter character has been taking place of late years in the work of professional engineers. This has largely come from the development of our manufacturing institutions from the position of being a minor factor in our economic life to being one of commanding importance, and the necessary employment of skilled engineers to conduct their technical affairs.

The engineer of the user and the engineer of the maker have widely different duties. Consider how different may be the information required in practice by two classmates, whom we will designate as "A" and "B," who graduate from college as engineers. We will suppose that "A" secures a position in the engineering department of a city, and commences his work, which may be the designing of a new water pumping station. His college course has fitted him for the work. His text books were suited to problems of this character. He finds abundant information on all branches of the subject, in data published in the proceedings of scientific societies, in technical literature, and in annual reports of city departments. The forms of contracts to be entered into are at hand, all found elaborately drawn, with every point safeguarded, and need only a little selection and adaptation to suit his case. They place in his hands the power to decide absolutely and without appeal all questions which may arise in carrying out the work.

"B" obtains employment in the engineering department of a manufacturing corporation, which in due time is to submit a tender for the construction of the pumping plant for which "A" has issued specifications. He will find that the form of contract proposed by "A" has many minute and carefully worded clauses to bind and limit the supplier. The tender to be submitted for the execution of the work must in its scope and wording protect the interests which "B" represents, not only in a general sense, but in every one of the clauses of the proposed contract. Every obscure phrase and every adjective used by "A" must have definite consideration and be clearly defined in both an engineering and a legal sense. "B" here finds that the information derived from his college course is meager, and there is no technical literature which he can use, either as a general guide for making a form of tender, or the proper expressions to use to define or limit the obscure clauses or words found in the specification.

Looking at the subject from a purely technical point of view, we see quite as great a variation in their work. In the case supposed, "A" would require only a general knowledge, while "B" would require the most thorough and exhaustive information of the qualities of constructive materials, and shop practice available in that particular location. The farther we carry the comparison of their work, the more clearly it is seen that the educational needs are becoming more and more complex, to correspond with the growing specialization of engineering work.

PRACTICE ABROAD.

There is another phase of engineering practice represented by the duties of "A" and "B" which now becomes interesting, if the work of American engineers is to take the place in the world at large to which the indications now so plainly point. In other countries it is a common practice for "A" to make all the general designs and all of the details for engineering work, and the supplier has no responsibility for either, or for the efficient working of the plant when completed. If errors or omissions are found in the drawings or specifications, the cost of the changes required is paid by the purchaser, in the usual bill for extra work. In this case, the duties of "A" are exhaustive, and those of "B" are small or disappear altogether.

AMERICAN PRACTICE.

The American practice is tending to the method of making the requirements issued by "A" of a general character which will cover the results sought, and leave to the supplier, "B," the work of designing the particular means to accomplish the desired end. Business has become of such a magnitude and so complex that one mind cannot fully grasp and readily handle the new discoveries, new materials, and new practices which now come so rapidly. For efficient and economical results, each phase must be handled by an expert.

There will be many "B" engineers to respond to the requirements of "A," and each will present for consideration different ideas, different materials, and different shop practices. "A" must select, from these various plans and details submitted, the one which best promises to fulfill the requirements. It is a division of labor between "A" and "B," each of whom, by tastes and training, is especially fitted for his part of the work. We may paraphrase their duties by saying that "A" is a judge, "B" is a counselor.

POST-GRADUATE WORK.

At the present time we cannot expect our technical schools, painstaking and perfect as they are, to fully prepare both "A" and "B" for such new and varied duties, or even to have their instruction in engineering fully abreast with the latest practice, or at least not until progress in the arts and sciences has substantially ceased. It takes time for a new practice or a new result to be recorded, published, considered, and adopted by the teaching staff.

This difference between the teaching and the engineering practice of the day is not only an indication of progress in engineering, but in some measure is an index of its rate. The student, then, must expect, as a normal proceeding, to supplement his graduating acquirements by practical experience, together with a personal contact with his professional brethren, in order to place himself fully abreast of the times, and to be fitted for the most effective and useful engineering service.

Engineering theory and practice are rapidly extending with the general advancement of our economic interests, and the engineer, whether he be a young graduate or otherwise, who does not make use of the modern aids to information, among which are to be counted scientific societies, and a personal association with his brethren, with the innumerable hints and suggestions which come from these, will soon be found struggling with what seems to him adverse fate, but what, in reality, is inferior knowledge, behindhand knowledge, or, plainly speaking, ignorance greater or less. The engineering world has passed by him, and he must then view the working out of the law of the survival of the fittest with what grace he may.

LABORATORY DEVELOPMENT.

An interesting development in the engineering world of the present day is the rapid growth of the experimental equipment of our colleges and technical schools. There seems to be no limit to the expense and the completeness of the illustrative and experimental machinery which is being installed for the instruction of the students of these institutions. And not less valuable is the learning, industry, and skill of the professors in charge of and directing these schools, whose theoretical acquirements are supplemented by being in constant personal touch with the industrial and economic interests of the country.

It is possible that by an organized effort the magnificent equipment of trained professors and experimental apparatus could be brought in closer touch with each other, that to a material extent their work and investigations might be made to proceed on a predetermined plan. This would broaden their field of experimental investigations, lessen the duplication of work, systematize the publication of results, and more rapidly extend our growing fund of accurate engineering data.

The engineering and scientific work of to-day uses one or the other of two systems of metrology—the English or the metric. The discussions of the relative importance and the desirability of these systems of weights and measures are frequently interesting, and may to some extent be useful in familiarizing the terms and making easier the conversion of quantities from one system to the other. Practical engineers can, however, lay aside academic discussions on the advantages or disadvantages of either, and recognize that the two great systems of metrology are each used by great engineering nations to the practical exclusion of any other, and they may safely assume, without discussion, that they are not likely in the near future to be changed in any material way by those using them.

It is especially desirable that English-speaking societies shall give every practicable aid to engineers using the metric system of measures, that the work of their engineers may be readily available and with the least possible trouble in making conversions of quantities from the English to the metric system. Such computations are always troublesome to perform, and distracting to the mind when undivided attention is required by the subject matter of the article. If the numerical expression in English measures is followed in a parenthesis by the exact metric equivalent, the article is practically translated when printed, as most engineers using the metric system read the English language, although they may not speak it, or readily make numerical conversions. The greater the availability and the publicity given to the published proceedings of a scientific society, the more nearly has the society accomplished the chief object of its existence.

It has long been evident that we were making rapid progress in perfecting our manufacturing machinery, as well as organizing and developing our industries, thus constantly increasing the efficiency of our labor, until we have reached a point where an hour's labor with its facilities produces more of our principal products, and transports them farther, than an hour's labor will do in any other part of the world.

The late war has revealed to us the fact that we have gone on reducing the cost of our products, and increasing our capacity for production, until our country alone does not furnish a sufficient market to insure steady work for our labor, and prosperity for our merchants and manufacturers. Like confined waters, the tendency of these increasing economic forces has been to break out from their confinement and equalize trade conditions by seeking a market in the world outside. If articles which are necessary to supply the wants of man can actually be made here with less labor and cheaper than elsewhere, here they will surely be made, though it modify our traditional ideas of isolated position and our protective theories.

One hundred years ago the iron trade of Sweden was greater than that of England, and, remembering the great changes which have taken place in the last hundred years, it would be rash to assume that the momentous economic changes which are now taking place may not cause an equally great shifting of the centers of more than one phase of industrial activity.

SCIENTIFIC SOCIETIES.

Every age has produced most ingenious and able engineers and mechanicians, as is conclusively shown by specimens of their work. Many of these have been preserved and handed down to us, causing us to wonder at their skill when we consider the limitation of materials then available, and in their time the paucity of exact knowledge of the laws of nature. But the special knowledge and experience of those masters in the art practically disappeared when death claimed the originators, as only a small portion usually remained in the minds of the pupils, and but little of this was transmitted to posterity. It was only when scientific and technical societies for the preservation of accurate records had developed, in the fullness of time, making all the world pupils, that the valuable knowledge so laboriously obtained was preserved and handed down to those who, sooner or later, could utilize it for the comfort and the advancement of mankind.

These lately developed scientific societies, which are so prominent a feature of the present age, were organized for the discovery and the universal diffusion of scientific knowledge—an object entirely different from that of all mediæval guilds and trade organizations. At first they were largely philosophical, discussing theories and experiments which at the time appeared to the community at large to have little or no direct bearing on the practical affairs of life.

The members presented to the society the results of their investigations and experiments, in the form of written papers, making them permanent records to be consulted and made available by others who were contemporaneous or who would succeed them. This was the vital germ which was to develop and elevate science and its applications in industrial work in succeeding ages. These societies thus became, so to say, the savings banks of our civilization, the repositories and guardians of the results of investigations, experiments, and experience that otherwise would have been lost to the world.

As industrial interests became more important, other societies sprang up, each devoted to some particular phase of scientific or technical work; each gathering, selecting, and recording data, not alone for their members, but to become permanent additions to the general fund of scientific and engineering knowledge. The growth of these societies has been accompanied by a gradual decrease of secret methods of manufacture, formerly so prominent, but which have now practically disappeared in our industries. Manufacturing supremacy is now decided by other factors.

The advance made in the accumulation of useful data and more accurate knowledge in practical engineering gained one season is presented to a scientific society the next, and still later it will be embodied in text books for the instruction of students who are soon to take our places and carry on our work. Until attention is called to the subject, we are not likely to realize that, in their essential parts, the great bulk of the engineering data available to us now has been first presented to a scientific society, and there permanently preserved until the time came for its utilization or application. It is this great fund of information, principally accumulated during the last century, that we draw upon for the materials for our text books, our general treatises, and our engineering hand books.

APPLIED SCIENCE.

Turning now to the effects of this accumulation of scientific data and literature available to all alike, and the results following its application by organized methods of procedure, our first glance will show prominently the wonderful and rapid increase of the importance of engineering in our industrial life. It has transformed almost every phase of it, and put into our hands materials and processes which make the actual life of our immediate ancestors seem primitive by comparison.

Commencing under adverse conditions and developing in a field of restricted capital, with scarce and high-priced labor, engineering in America has applied the forces and materials of nature to the uses of man in a characteristic way. Freedom from mediæval traditions and the hampering conditions found in the older countries left them substantially free in the choice of means to accomplish their end. Influenced as our engineering has been by the experience and the work of other parts of the world, yet we cannot escape the fact that its development was essentially independent, and in some phases unique.

Improvement has followed improvement in technical matters, profits and savings have been added to the capital invested in our industries, until our country, two hundred years ago an untraversed wilderness, one hundred years ago a struggling nation—struggling with industrial difficulties and serious political problems—has triumphed over those early limitations, and has developed into a nation which in numbers, prosperity, and wealth takes a prominent position among the great nations of the world.

THE ADVENT OF THE ENGINEER.

Whichever way we turn, we behold marvelous changes, which have followed the advent of the engineer on the scene. A view of one subject will in a measure serve to represent these changes, and to recall similar illustrations to your minds which differ from this only in degree.

It is but a few years, well within the memory of men now living, that our navy and all the other navies of the world were composed of sailing ships. In one of these vessels a mechanical germ was introduced in the form of a steam engine and an engineer. The grave question soon arose as to what should be the status of the new intrusion into the personnel of the ship, the engineer. This factor, which was soon to revolutionize the navy, was considered unimportant at that time, as is shown by the first official record on this subject in the Navy Department at Washington, stating that it would seem that such persons should be exempt from the penalty of corporal punishment.

The engine grew in size with each succeeding vessel, and as it increased, the sails correspondingly shrank, until finally they disappeared altogether. Other mechanical germs also found a lodgment in the ship, which has so developed that hydraulic and pneumatic pressures are produced, and electric currents are generated and distributed, to govern the rudder, hoist the anchor, ventilate the compartments, energize the combustion, revolve the turrets, train and control the guns, handle the ammunition, and purge the ocean's water of its impurities, making it wholesome for the ship's use.

Following these in quick succession came incandescent lamps and search lights, breech-loading and rapid-fire guns, multicharge automatic guns, and mobile torpedoes—one mechanical appliance rapidly following another, until the ship-of-the-line, which but just now embodied the result of hundreds of years of thought and experiment, has been completely transformed from keel to topmast into a vast machine, controlled and operated, even to the least important function, not by sailors, but by mechanicians.

In every phase of our industrial life the changes wrought by the engineer are quite as evident; for instance, note the marvelous changes in the manufacture of steel, in the development of electric locomotion, in iron building construction, in machine tools, in agricultural implements, in sewing machines, in textile industries, in electric metallurgy.

HIS WORK.

The life of the engineer has a full measure of the labors, the trials, the discomforts, and the disappointments which are found in this as in every other walk of life. But it also has the successes which come from well directed labors. It is not, however, either the useful work in itself or what are called the successes of life which brings happiness. It is man's ideals which make him happy.

Let us together survey some of the surrounding influences which tend to give high ideals of life to the engineer, no matter what the trials or the vexations of the moment may be. We will pass in review the interesting character of his daily work, his pure minded associates, the higher pleasures of life, and the fascinat-

ing scenes by which he is surrounded. We will then better appreciate with what elevated emotions a father can lead a son, or a teacher his pupil, to the path of an engineering life, and place in his hands the mathematical, chemical, and physical implements to enter upon a work which will bring to him usefulness, pleasure, and honor.

Whichever way engineering may develop as time rolls on, its elevating influences are constantly at work on the mind and on the character. The work is carried on under unchangeable laws, which must be rigorously applied and adhered to, or failure is sure to result. Man builds to master, to resist, or to guide the forces of nature. If he has rightly judged the conditions, his work stands as a permanent monument of the fact; but if otherwise, the irresistible laws of nature will develop the defect and discover his ignorance, incompetence, or error to every observer.

Hence he laboriously seeks out the unseen laws and forces of the universe, then expresses the revelation in a workable form for his daily use. He tests his materials with painstaking refinement. He measures electric resistances with an accuracy now reaching the point of one in four millions; time to the one-millionth part of a second; divides a circle with a mean error not exceeding the one-millionth part of the circumference; makes surfaces six inches square with a variation from absolute flatness of less than one two-hundred-thousandth of an inch, and parallel within one second of arc; rules lines which vary from absolutely perfect spacing by only one three-millionth part of an inch; measures his optical work with a wave length of light as a unit of distance, and handles this unit of the one forty-thousandth of an inch as easily as a mechanic handles a rule; sees clearly the spectrum of samarium when one part is diluted with three million parts of lime; and surveys lines eleven miles long, in the open air, with an average variation in three measurements of only four-tenths of an inch.

HIS ETHICS.

The effect of living and working in such a sphere of action, where it is inconceivable that an engineer could knowingly be otherwise than exact in his work, should tend to influence the whole trend of his life and character, and make them to a greater or less degree a reflex of his daily work. He of all men has the most unchangeable and exalted basis for his ethics—the clearest of all knowledge of the disastrous results which will surely follow the violation of law. The very qualities of his mind which make his work a pleasure and a success will all tend to bring his every act into compliance with the inexorable laws of the universe. If it is otherwise, and his conduct is not guided by and his ethics are not in accordance with the laws of right doing and right thinking, then, and to that extent, he is not an engineer—not one who is skilled in the application of the laws and the forces of nature to the uses of man.

HIS PLEASURES.

It is with hesitation that I ask you to contemplate the pleasures of life enjoyed by those whose daily walk is thus surrounded. Words fail to describe the exquisite pleasures and the noble aims which are inspired by the contemplation of the wisdom and beneficence of the laws of the universe, which the diligence of man has revealed to us. Who can estimate the satisfaction which comes to the mind of the engineer from the knowledge that his work, the fruit of his investigations, and the wisdom of his decisions will be judged, not by fallible human methods and its caprices, but by the infallible and immutable laws of the universe!

Then consider the pleasure which comes from working in the open air, in the broadest light, where every interested one can see his difficulties, his investigations, his adaptations, and finally, if God has given him ability equal to the task, his solution of the problem. When victory comes, he is given the honor due to the work in unstinted measure, and he can accept it with propriety and count the commendation as one of the pleasures of life.

It is inspiring to the earnest engineer to feel that the actual workings of his mind, and his inner and fundamental conception of the forces of nature, of resistances, of materials, of workmanship, will be shown in his works as in a mirror. Roebling, Ericsson, Sir Benjamin Baker, and Edison have worked, as it were, in a glass house. Their thoughts and judgments are shown to all the world, not by inadequate words, but in the works of their hands—the Brooklyn Suspension Bridge, the turreted Monitor, the Forth Bridge, the quadruplex telegraph, the inclosed filament whose electric conductivity increases with the current.

Then he has the gratification to the mind which is found in comprehending and intellectually seeing, as clearly as in a diagram, the theoretical lines of the forces in a structure, and then clothing those lines with materials of strength and resistance, to make them realities, and adapted to do the everyday work of life. The Brooklyn Suspension Bridge by Roebling shows an almost ideal correspondence of the two, so that it may represent either theory or practice, depending on which way at the moment he chooses to look at it. Again, he uses a system of weights that cannot be seen or handled, the purely intellectual atomic weights—yet the rock under our feet is not more firm and real than is the work done with these intellectual aids.

HIS ENVIRONMENT.

Working in a field and in touch with a body of his fellow men having similar tastes, he sees on every hand scenes of engrossing interest—the telescope photographically recording the position and motion of stars which no human eye has ever seen; the spectroscope analyzing the materials of the sun and stars with all the accuracy which it would show if the articles were in the laboratory; looking with Roentgen rays through a double-barreled rifle, and seeing not only the leaden bullets within the steel barrels, but also the wads and the charges; and photographing lines in the ultra-violet and infra-red spectrum far beyond the reach of our vision.

He stands by a quartz filament galvanometer which indicates an electric current so minute that if it should be increased in magnitude eight hundred thousand times, it would still be only the one-millionth part of an ampere; and on the other hand, in contrast, sees the Niagara electric generator of five thousand horse-power, with a current so much larger than that of the galvanometer that the difference can only be expressed mathematically, not in colloquial language. He sees with entrancing interest the liquefaction of hydrogen at a temperature of only twenty-three degrees Centigrade above absolute zero; and, again in contrast, sees what promises to be a rosetta-stone in astral analysis, in the precise correspondence of the spectrum of the star gamma Cygni and that of the chromosphere of the sun.

He shares in the enthusiasm at the results of two years of unremitting work in the extreme part of the known spectrum in isolating a new element, monium; in the Hertz electro-magnetic waves now applied in wireless telegraphy; in the newly discovered element, polonium, whose radiations make the air through which they pass a conductor of electricity.

More nearly touching him personally comes the work of the biologist, whose quest for the thing we call life has continued from the primitive man to the present time. Constantly flitting from his grasp, it has seemingly passed from fire and storm to mountain and deep, from animal and plant to flower, to seed, to cell, and now it has been followed to the molecule or the atom; and yet it as completely eludes his grasp, or even his comprehension, as it ever has. But followed it certainly has been, by all the laws and forces of nature at the command of man, until the search for it is now in the atom, a space physically so small that only the trained imagination can faintly comprehend its minuteness.

And there, on the outskirts of this unexplored world, stands man, with spectroscope and polarized light, peering into the sphere of action which we call an atom, well knowing that therein lie wonderful forces, activities, and at least the effects of that mysterious entity, life itself. He sees a field for investigation so fraught with possibilities, so infinitely beyond the comprehension of any conception which we can form of the capacities of the human mind, that he stands gazing into the abyss with the same devout wonder and awe as does the astronomer when viewing the illimitable heavens. The two are standing, as it were, back to back, and each is gazing into an infinity—one into the infinitely great, and the other into the infinitely small.

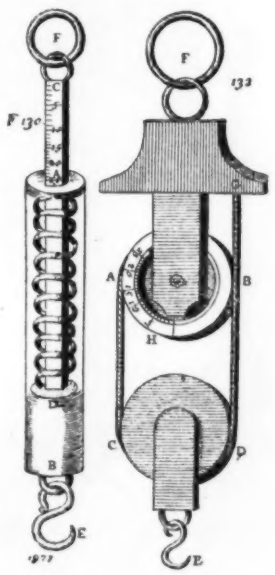
Thus stands the engineer in the midst of a countless number of earnest explorers in the field of unrevealed nature, and, so to speak, sees the tools forged and the materials discovered with which he is to work. Cheerfully can he enter upon his daily task with the consciousness that his application of these discoveries is of real service in lightening the burdens of our life, as well as elevating and ennobling his fellow men.

The scenes which we have just brought to our intellectual vision are not those of the untrained imagination, of rhetoric, or of unreality, but those of the most rigorous truth, among the most real and matter-of-fact things known to us in all the realms of nature, and brought before you in the plainest language at my command.

We have traversed a wide field together, and now, as we draw near to a personal parting—never to meet again under similar circumstances—let us, as we travel the way of life, appreciate its elevating pleasures, and carry to our daily tasks and to our homes a higher realization of the dignity of the life and of the work of the engineer.

THE ORIGIN OF THE SPRING BALANCE.

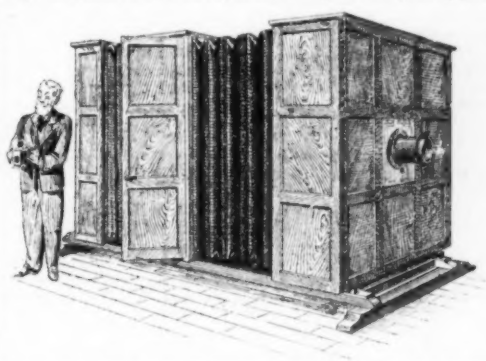
VERY little information appears to be available as to the origin of that simple and widely adopted contrivance the spring balance, but the invention is certainly at least two hundred years old, as it is described in Ozanam's "Récréations Mathématiques et Physiques," published at Paris in 1694. The accompanying illustration is reproduced from plate 46 in the second volume of that work. The figure on the left-hand side shows a balance with an inclosed spiral spring, which is stated to have been invented some little time before



in Germany, and it is described thus: "On a inventé depuis peu en Allemagne un nouveau peson, qui se peut aisement porter à la poche, & dont on se sert tres-commodément pour peser promptement & facilement un Poids d'une grandeur mediocre, comme du Foin, des marchandises, and autre chose semblable, depuis une livre jusqu'à cinquante livrès, & davantage. Cette machine est composée d'un tuyau ou canon de cuivre A B, foncé par les deux bouts, long d'environ six pouces & large à peu près de huit lignes, dans lequel il y a un ressort d'acier A D, fait en vis comme un tire-bourre d'Arquebuse. Il y a par le bout d'en haut, c'est-à-dire, vers A, un trou quarrée par où passe une verge de cuivre C A D, aussi quarrée, qui traverse le ressort, dans laquelle sont les divisions des livres qu'on y a marquées en appliquant successivement au crochet E un poids d'une livre, de deux livres, &c." The construction is, however, quite clear from the engraving. The other figure represents a form of spring balance devised by Le Sieur Chapotot, Ingénieur du Roy et Fabricateur des Instruments de Mathématique à Paris. The two pulleys, one secured to the suspension eye and the other to the hook, are connected by a cord fixed at one end, and at the other attached to the upper pulley, which incloses a clock spring, and has a scale on its rim. The "Encyclopédie Methodique," in 1782, states that the invention of the spring balance is attributed to the Germans, but that some people say it belongs to the artisans of Besançon from which town those articles were first brought to Paris. One of the forms described in the "Encyclopédie" consists of a metal bar bent to an acute angle and two smaller curved bars—one, fixed in the extremity of one of the limbs of the bent bar, and passing through a slot in the other, carries the hook at its free end; the other, fixed in the second limb, and passing out through the first, has secured to it the suspension eye and has a scale cut on its face.—Engineering.

A GIGANTIC PHOTOGRAPHIC APPARATUS.

THE mammoth process camera, which attracted the attention of every one at the recent exhibition at the Crystal Palace in London, is certainly the largest appa-



A MAMMOTH PHOTOGRAPHIC APPARATUS EXHIBITED AT THE LONDON CRYSTAL PALACE.

ratus of the kind that has ever been constructed. This camera, in which a man six feet tall can easily stand upright, is designed for the work of ordinary reproduction or line photogravure. It cannot be used for the half-tone process, because the largest of the ruled screens necessary for this kind of work do not exceed 40 × 30 inches, while the sensitized plate that the camera is capable of accommodating measures 60 × 70 inches. The exceptional dimensions of the plate necessitate the suppression of the negative frame, which in fact would have to be of a size that would make it too bulky and heavy. It is the laboratory itself that forms the negative frame and protects the sensitized plate, which is placed directly at the back of the camera, where it is held by movable bars. The back of the camera must consequently be connected hermetically with a bay formed in the laboratory. The full extent to which the camera can be drawn out is 12 feet; so, when an objective of a focal length of 60 inches is employed, it is possible to obtain reproductions of the same size as the original. It is possible, as in ordinary apparatus, to employ various objectives of shorter focus, which then form the image upon a plate placed in the center of the apparatus upon a special support. It is thus possible to use smaller plates than the ones above mentioned.

The focusing is done in a peculiar manner. A door gives access to the central part, which thus forms a small chamber of about 40 × 80 inches, in which a person can sit with ease, and even with pleasure, if we are to believe the Prince of Wales, who honored this little "salon" with his presence.

The objective, which was made by Ross, is of the symmetrical type, has a focus of 60 inches, and operates diaphragmed to f/11. This immense apparatus is completed by a screen for the centering of the object to be reproduced, and which slides on rails. Its central portion is so arranged that, for reproductions in colors, the image to be copied can be inclined at different angles so as to obtain a proper crossing of the lines.

The light for the work executed with this apparatus is furnished by electric arc lamps provided with spherical reflectors, so as to obtain a constant direction as well as a steadiness of the light.—La Vie Scientifique.

The method of erecting Egyptian obelisks has long puzzled the student of Egyptian antiquities, and the numerous documents and wall-pictures found do not explain it. In a late issue of Construction Moderne, Mr. J. C. Kruseman suggests a possible method of handling blocks of stone weighing as much as 1,000 tons, and sometimes 131 feet high and 10 feet square at the base. These blocks were also placed on pedestals considerably raised above the actual level of the soil. Mr. Kruseman finds that these obelisks were generally placed in front of pylons or temples. He believes that the Egyptians first built a slightly inclined causeway of sand or other material, equal in height at one end to the obelisk to be erected; ending at the end in a strong wooden crib, and leaving a space between the crib and the temple for the obelisk. The base was then built and the space between the temple and the crib was about half filled with sand; and on the face of the crib a strong inclined chute was constructed leading to the base. The obelisk was then rolled up the incline on hard wooden rollers; and, with tackle leading to the temple, it was then allowed to tilt over the front of the crib, falling into the sand and guided by the chute. By slowly and carefully digging away the sand and hauling on the top of the obelisk it would thus be gradually sunk, until it would finally rest on its base.

[Continued from SUPPLEMENT, No. 1199, page 19287.]

SUBMARINE CABLE GRAPNELS.

By CHARLES BRIGHT, F.R.S.E., A.M. Inst. C.E.

MUD GRAPNELS.—The usual grapnel employed on bottoms of very soft mud is similar to that shown in Fig. 1, but is provided with prongs which are sometimes as much as 4 feet or 5 feet in length.

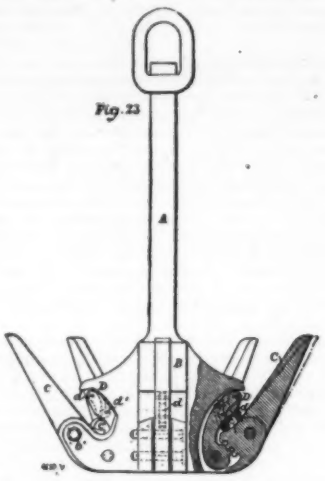
Johnson's Mud Grapnel.—This grapnel, illustrated by Fig. 15, has two steel prongs which are comparatively thin, but deep in section, so that little resistance may be offered to their penetration into the mud. The prongs are connected to one end of a broad, flat plate, which constitutes the shank, the plane of which is at right angles to the plane of the prongs. In dragging with this grapnel, the shank or stock slides with its flat face over the surface of the mud, while the downward-directed prong penetrates to its full length into the mud.

SPECIAL GRAPNELS.

In 1866, when Sir Samuel Canning succeeded in raising the end of the 1865 Atlantic cable from a depth of over 2,000 fathoms, by employing one ship to sever the cable while the bight was held suspended by the other, Mr. Latimer Clark, F.R.S., had suggested the employment of a grapnel which would securely grip the cable and then cut it in two, one end only being brought to the surface. He subsequently devised an apparatus to effect this object, a description of which was published in the Mechanic's Magazine of July 20, 1866. Mr. Clark's cutting and holding grapnel was not, however, actually employed for the recovery of the cable: instead of it, an ordinary grapnel was used, fitted with sharp edges in its bed (Fig. 16), so as to expedite rupture under a certain strain, thus avoiding the necessity of heaving up any great distance before breaking the cable. Clark's patent included an ingenious arrangement for absorbing the effect of any pitching motion of the vessel on the cable, by means of an elastic pulley forming a part of the dynamometer, which allowed for as much as 50 feet play of cable, thus materially lightening the strain. The explanation of this excellent contrivance not being adopted in practice is presumably (1) on account of the acknowledged axiom that it is false economy to attempt to repair when the weather is such as to cause the ship to pitch to any extent, and (2) that such an arrangement would tend to defeat the ready detection of the difference between the grapnel fouling a rock (or such like) and of a steady strain due to cable hooked, owing to the sensitiveness of the dynamometer being naturally reduced thereby.

Clark's cutting and holding grapnel, the first of its sort, was improved on by Mr. Frank Lambert, who, in 1876, read a paper before the Society of Telegraph Engineers on "Grapnels for Raising Submarine Cables in Deep Water." Mr. Lambert's grapnel was subsequently improved on by Mr. Claude Johnson, and as his was the first of the kind which proved completely successful, a description of it is given here.

Johnson's Cutting and Holding Grapnel.—General views of this grapnel are given in Figs. 17 and 18, while Fig. 19 shows a face view with one side in section. The cable, on being hooked and lifted, forces its way through the rubber shield, *K*, which is provided to keep the mechanism clear from stones, sand, etc., while towing over the bottom, and becomes inclosed in the jaws of the hinged clip, *G*. As the strain increases the hinged clip shears through a leaden bolt, *H*, which supports it, and, moving upon its pivot, is forced down the tapering sides which press the sides of the clip together so as to grasp the cable very tightly. The greater the strain on the grapnel rope, the more the clips are forced down and the tighter the cable is held; until at last the clips sink so far as to cause the cable to make an acute angle over the knife edge, *L*, and the cable is



cut, one end falling to the bottom while the other is brought to the surface.

Johnson and Phillips' Cutting and Holding Grapnel.—This grapnel is on an entirely different principle to the preceding. It is very complex, and explanation in a few words would be impossible. The full specification of the patent should, therefore, be referred to.

Lucas' Cutting and Holding Grapnel.—This grapnel has two prongs and two hinged arms which are held extended by a leaden bolt (Fig. 20) and which are provided at the extremities with cutting knives. These arms are connected to the shank by a wire rope, one end of which passes up the inside of the shank and is shackled to the grapnel chain. As soon as the strain on the grapnel rope reaches a prearranged figure, the pull of the wire rope on the extremities of the arms is sufficient to break the leaden bolt, and, turning on their pivots, the arms are pulled with great force toward the shank. Should the cable have been hooked, it is jammed between the curved portions of the arms and the shank; one side, however, will have been cut by the knife, and falls to the bottom in consequence. The knives can be easily arranged so that either side of the cable can be cut at will, provided the dragging is always carried on in the same direction.

It is obvious that this grapnel is liable to close, through the prongs fouling hard ground or soft mud and clay. It is, therefore, chiefly of use on soft bottoms, such as are fortunately found, as a rule, at great depths; or, as has been done, the cable may be hooked with an ordinary grapnel and the bight raised off the bottom and buoyed. It can then be readily hooked with this special grapnel, as devised by Mr. Lucas, without any danger of injury from touching bottom.

Benest's Gripping Grapnel.—The object of this grapnel is to hold a cable fast when once it is hooked. The advantages in this are manifest. There will be no slipping of the cable over the prongs, and, if a loose end is caught, it cannot escape. In raising a bight, should the cable break at the weak spot, one end will still be recovered. Fig. 21 shows in side elevation a grapnel of the simpler form and Fig. 22 a portion of the same grapnel with one end of the flukes securely gripping a cable. It will be seen that the weight of the cable on the inside of the prong causes this to turn on its pivot and grip the cable against the large boss on the shank of the grapnel.

An improved form of Mr. Benest's grapnel is shown in Fig. 23. In this the jamming action is double. Not only does the prong meet the boss, but a jaw—which is geared by teeth to the heel of the prong—advances toward the prong, and effectually prevents the cable escaping, should it by any chance become slack during the process of raising the grapnel.

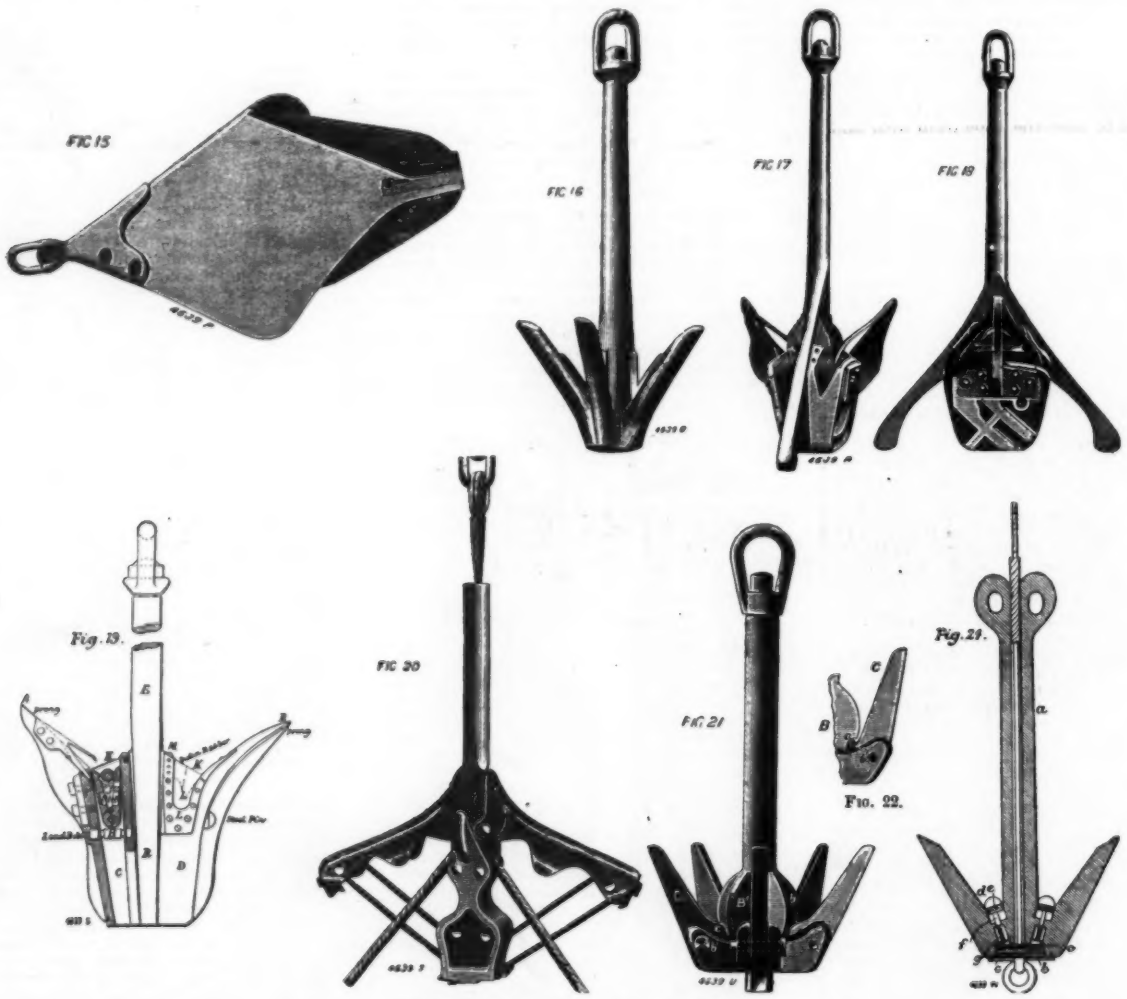
The surfaces between which the cable is held are carefully constructed, so that there is no cutting action; and it is found that the cable breaks at the nearest weak point, rather than on the grapnel. Long or short prongs are provided, so that the grapnel is suited for both hard and soft bottoms. A very full description of Mr. Benest's apparatus appeared in The Electrical Review of May 2, 1890.

Cutting Grapnels.—These are ordinary grapnels provided with a sharp edge (see Fig. 16) on which the cable rests. They are seldom used now, having been superseded by the various cutting and holding grapnels and by the gripping grapnels above described.

SIGNALING GRAPNELS.

Anderson and Johnson's Indicating Grapnel.—This is a grapnel designed to give intimation of a cable being hooked by sending an electric current to the ship. An insulated coil of wire is placed round each prong and connected by an insulated conductor, passing along the inside of the grappling rope, to the ship. While grappling is going on, reversed currents are sent by shore through the cable; and when the grapnel has hooked the cable, these currents are at once signified on board by the induced current in the insulated coil.

The same patent also includes a swivel for use with the special grapnel rope required.



SUBMARINE CABLE GRAPNELS.

Trott and Kingsford's "Tell-Tale" Grapnel.—A distinct improvement on the previous grapnel was made soon afterward by Mr. H. Kingsford, and is shown in Fig. 24. In this invention, directly the cable is hooked contact is made between two metallic surfaces, by which a circuit is closed and a bell rung (or the needle of a detector deflected) on board the ship. The presence of the cable on the grapnel is thus immediately revealed, thereby avoiding the chance of dragging the cable along the bottom or going through it when the dynamometer gives insufficient indication. Should one of the prongs be broken off on rocky bottom, the cir-

cuit will also be closed, though with increased resistance. On the warning being received, the engines are at once stopped and the grapnel picked up, thus saving time and patience.

The shank, *a*, of the grapnel (Fig. 24) is made hollow to allow an insulated wire to pass through it. This wire is inserted in the heart of the grappling rope when the latter is manufactured, after the pattern patented by Messrs. Trott and Hamilton. The conducting wire connects the ship with a plate of metal, *b*, placed between two stout pieces of rubber, *c*, in a cavity contrived in the lower end of the grapnel. At the points of intersection of the prongs and the shank are placed buttons, *d*, in two halves, between which is a thick rubber cushion, *e*. A needle, *f*, passes through this cushion and the lower half of the button, the point resting on the top of the sheet of rubber, *e*. A spring, *g*, keeps the needle in this position. The water is allowed free access to all parts of the apparatus (with the exception of the metal contact piece, *b*), so as to equalize the pressure throughout when grappling at great depths. As soon as the cable is hooked it commences to exert pressure on the button, *d*, which is forced down, driving the needle through the sheet of rubber, and making contact between the metal plate and the sea; the electric circuit is then closed, and warning given to those on board that the cable is on the grapnel.

This ingenious system has been tried, in the Atlantic and elsewhere, with good results. It is especially adapted to grappling in deep water, on account of the great difficulty of knowing when the cable has been hooked, with a long drag rope and heavy normal stress for the dynamometer; and also owing to the long time occupied in making certain that the line has been hooked (by heaving up the slack) before the peculiar springy feeling indicating "cable hooked" is experienced. The system has, however, the disadvantage of necessitating a grappling rope in one continuous length, without connecting shackles, the swivels of which in the ordinary line allow the grapnel to turn over on the bottom without twisting up or untwisting the ropes. The length of chain which is generally attached to the grapnel to save the rope from wear and tear on the bottom has also to be abandoned here. If an ordinary grapnel rope could be used instead of the somewhat unwieldy Trott and Hamilton line, it might be more successful—i. e., there might not be so much trouble in the handling of the rope. There would, however, always be the difficulty of its requiring to be made in one continuous length (for the sake of the insulated conductor inside), with no intermediate shackles which allow the turns of each length of an ordinary grappling line to come out. The result is that, in the Kingsford system, the turns all come on the slack part inboard, causing much inconvenience by the increased length of slack cable. Besides the objection of the rope being difficult to coil and stow away, except very slowly, the insulation is also liable to be troublesome.

The whole system is fully described in a communication to The Journal of the Society of Telegraph Engineers and Electricians of November 29, 1883, by Mr. Kingsford (vol. xii., page 490); and details of its working, with extracts from diaries kept during repairing operations, are given in a communication by Mr. F. A. Hamilton. (See vol. xxii., page 243, of the same journal.)

Anderson and Kennelly's Grapnel.—This grapnel is provided with a contact maker which completes a circuit, should the grapnel be in an upright position. It thus affords indication as to whether the grapnel is towing on its side properly or is off the bottom.

GENERAL REMARKS.

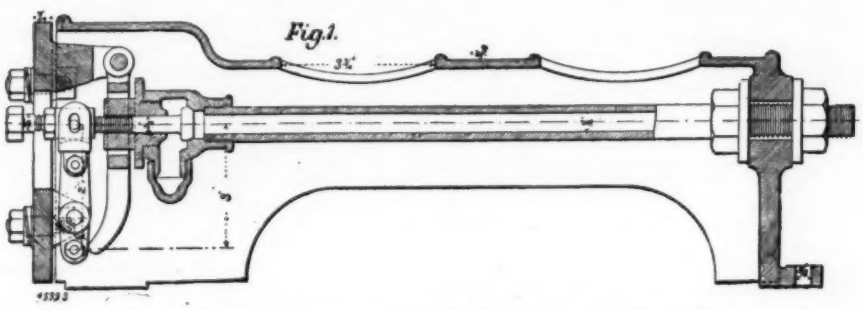
Though, as we have seen, there are grapnels specially adapted for dragging along a mud bottom—such as will pierce and sink into it most readily—it may be stated generally that it is almost impossible for any species of grapnel to pass over a cable in any other but a rocky or sandy bottom. Ooze is peculiarly favorable ground for grappling work. For sand, the grapnel prongs should be extremely sharp.

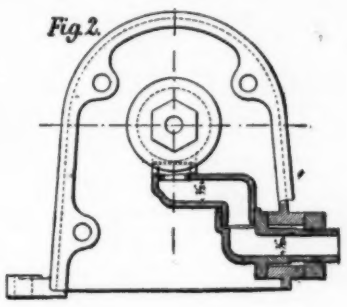
When effecting repairs in such depths as render it impossible to raise a bight of the entire cable to the bows of the vessel, the custom is to use one of the cutting and holding grapnels described in these articles. The cutting operation does not, however, take place at the bottom, for here there is comparatively little strain, and it would, therefore, be almost impossible to ascertain when the cable had been cut. The automatic cutting apparatus is designed only to come into play under a certain prearranged strain, and the practice is to lift the cable until this strain is reached, say about 1,000 fathoms, when the severance of the cable instantly shows itself by the drop in the strain on the grappling line, as indicated by the dynamometer.

Grapnels employed in submarine cable work range from about 4 feet to 5 feet in length, and their weight varies from about 1 cwt. to 5 cwt. It may not be out of place to remind those who are responsible for the working of them that they are too often treated as mere pieces of iron, instead of as instruments. It is, unfortunately, no uncommon occurrence for a grapnel, after use, to be relegated to the forehold without even being cleaned; and when required again, it is let down into the water in a rusty and useless condition, and its failure to accomplish what it is designed to do—and what it is perfectly capable of doing under proper management—is attributed to the grapnel itself, rather than to those who are responsible for it.

Each grapnel should have its proper place in the storeroom, and receive periodic cleaning and oiling. Unless this is done—and, in addition, unless the use and adjustment of the grapnel is thoroughly understood—it would be far better to adhere to the more ordinary patterns requiring less attention.

In nine cases out of ten, when a well designed grapnel fails to work, the fault is the user's, and not that of the grapnel.





OKES AND STUBBS' EXPANSION STEAM TRAP.

We illustrate an ingenious, and at the same time a very simple, form of steam trap, and one that should rank high among the numerous designs already in use for draining off water from steam pipes, etc.

It will be seen by the section that its action depends upon the expansion and contraction of a single brass tube, the motion of which is multiplied by a pair of compound levers actuated by the tube itself, the result being that the valve has a lift ten times that due to the expansion of the tube; hence it is exceedingly sensitive, and the valve has a large lift in the event of a sudden rush of water.

FIG. 3.—OKES AND STUBBS' EXPANSION STEAM TRAP.

The space occupied by a ¾ inch trap is 2 feet by 9 inches wide, by 8 inches in highest part. The trap is sold by Mr. J. C. R. Okes, Ormond House, 63 Queen Victoria street, London, E. C. The steam pipe is connected to the right-hand end and the water escapes under the valve at the left. When all is cold the valve is right off its seat, offering a passage equal in area to the pipe. The admission of steam causes the pipe to expand, and the seat and the valve advance to meet each other until the opening is tightly closed. As water accumulates the pipe cools and contracts, whereupon the valve leaves its seat and the water escapes. As soon as it is discharged the heat of the steam again expands the pipe, and the valve seats itself afresh. There is a screw by which the valve can be adjusted in relation to its seat, so that no leakage of steam can take place.

We are indebted to London Engineering for the article and engravings.

A NEWFOUNDLAND mechanic has invented a device for signaling at sea by throwing the reflection of letters upon the clouds. The signals are changed rapidly by a device resembling the keyboard of a typewriter.

AN OUTLINE OF THE HISTORY OF GEOLOGICAL SOCIETIES IN AMERICA.*

By JOHN J. STEVENSON.

SEVERAL travelers of the eighteenth century, among them especially Guettard, Alexander, and Schoepf, gave more or less important information respecting the geological structure and mineral resources of our country, but geological work, properly so called, began only with McClure's studies in 1806. The publication of his results, presented to the American Philosophical Society of Philadelphia, on January 20, 1809, led others to make studies, and soon afterward there appeared numerous papers dealing with geological subjects. By 1820 the students of geology had become so numerous that the American Geological Society was organized in New Haven, Conn., where meetings were held certainly until the end of 1828. Before another decade had passed there were groups of geologists in New England, New York, and Pennsylvania, while Olmstead and Vanuxem had made preliminary surveys in North Carolina and South Carolina, Troost had begun the survey of Tennessee and Hitchcock that of Massachusetts. In 1832 the Pennsylvania geologists, feeling much in need of an official survey of their State, organized the Geological Society of Pennsylvania to arouse public interest and thus attain the desired result. The volume of their publications contains papers which attack geological and economic problems of the first order, and their investigations were not confined to the State of Pennsylvania. Geology, however, was becoming too broad in its scope and its workers too numerous to be embraced by a local society, even though the list of correspondents was as large as that of the active members. In the Appalachian region of Massachusetts, New York, Pennsylvania, and Virginia serious problems were encountered which could not be solved within the boundaries of a single State, and a right understanding of the work done in one State was necessary to the correct understanding of the work done in the adjoining State. Correspondence proved a failure, incidental or casual talks led to misunderstandings, systematic conference was necessary, with a generous contribution by each of his knowledge to the other.

On April 2, 1840, as the result of a conference held in Albany in 1839, eighteen geologists met at the Franklin Institute, Philadelphia, and organized the Association of American Geologists, with Prof. Edward Hitchcock as chairman. Those present were the State geologist of Massachusetts, six geologists of the New York survey, six of the Pennslyvania survey, two of the Michigan survey, and three not connected with any public work. Mr. Martin H. Boye is the only survivor of the eighteen. The succeeding meetings in Philadelphia and Boston were attended by many geologists, of whom only Boye, O. P. Hubbard, and J. P. Lesley remain. A volume of the Association's proceedings published in 1843 contains several papers which made a deep impression on American geology. Here are the five great memoirs on Appalachian conditions by the Rogers brothers, Hall's noteworthy discussion of the Mississippi basin section, Hitchcock's elaborate discussion of the Drift, and many contributions by other members. Prof. Hall said on one occasion that the inspiriting effect of these meetings could not be overestimated. As one of the youngest members, he was impressed by the mental power of those great men, all untrained in geology, except Taylor, whose education under William Smith proved advantageous in many ways, but very disadvantageous in others, as it had provided him with a generous stock of well set opinions. Though wholly self-taught, working in a country sparsely settled, without borings, without railroad cuts, oil borings, mine shafts, or any other of the advantages so necessary to us, those men elaborated systems, made broad generalizations, learned much regarding the succession of life, and discovered the keys which were, in later years, to open mysterious recesses in European geology. The advantages of the union and personal contact were so manifest that the following year (1841) the naturalists applied for and gained admission to the Association.

In 1842 the first series of geological surveys practically came to an end and the geologists were scattered, many of the younger men being compelled to enter other callings. The Association of Geologists and Naturalists held its meetings regularly, but its strength diminished and, in 1848, it yielded to outside pressure, and became merged into the American Association for the Advancement of Science, which threw its doors wide open to all entertaining an interest in any branch of science. The first meeting of the new organization had a roll of 461 members. Comparatively little was done in geological work between 1842 and the close of the civil war.

The rapid development of the country's internal resources during the war and the attendant growth in manufacturing interests made necessary increased efficiency in scientific training, and enormous gifts were made to our leading institutions for that purpose. The importance of geological knowledge had become very evident during the development of iron, coal, and oil resources, and the geologist found himself suddenly elevated from a place surrounded by suspicion to a post of honor. Several government expeditions were

* Abstract of the presidential address delivered at the eleventh winter meeting of the Geological Society of America, Columbia University, December 28, 1898.

sent into the little known country west of the one hundredth meridian, each of which was accompanied by a geologist or a physician who understood something about geology. Within a decade after the close of the war, State surveys were undertaken in New Hampshire, New Jersey, Pennsylvania, Ohio, Indiana, Kentucky, Michigan, Wisconsin, Minnesota, Iowa, Missouri, and other States, while the Canadian survey, which had gone on uninterruptedly since the early forties, was made more extended in character.

The conditions which rendered imperative an association of geologists in 1840 were the present conditions in 1880, only more oppressive. The problems of 1840 were chiefly those of a narrow strip within the Appalachian area; those of 1880 concerned the whole continent. Geologists were increasing in numbers, but opportunities for making personal acquaintance were few; meetings of societies in midsummer could be attended only by those who were not connected with official surveys or who were detached for office work. Workers were gathering into little groups on geographical lines and there was danger that our geology would become provincialized. In 1881 the tension was such that several geologists connected with official surveys urged the formation of a geological society to bring about closer bonds among geologists, and they succeeded at the meeting of the American Association of that year in securing the appointment of a committee to consider the matter. This committee was not able to accomplish anything very definite, however, until 1888, in connection with the Cleveland meeting of the American Association for the Advancement of Science. Then, under the guidance of a committee of organization, consisting of Profs. A. Winchell, J. J. Stevenson, C. H. Hitchcock, John R. Procter and Edward Orton, a provisional constitution was adopted making the original membership of the new society rest upon membership in Section E (Geology and Geography) of the Association, thus avoiding a split with the parent society. Happily the high dues and a general belief that no society could be formed on the proposed basis kept the list of Original Fellows from being swollen by those whose relations to geology began and ended with attendance upon the American Association's meetings. Permanent organization was effected during the holidays of that year by the election of Prof. James Hall as president, and Profs. James D. Dana and Alexander Winchell as vice presidents, and the new society was fairly launched on the career which has amply justified its existence.

One great object of the society is publication; hence the choice of first editor was very important. Dr. W. J. McGee was selected for the office, and through his skill, care, and determination, the Bulletin at once took front rank among scientific publications, a position which it has always maintained. As a storehouse of fact and of broad, just generalization, the volumes of the society's Bulletin are excelled by those of no similar publication.

Fears and misgivings abounded when it was discovered that this society was a success from the start. The American Association for the Advancement of Science had been the one society for so many years that attempts at differentiation seemed to be efforts to cut away the pillars of scientific order, but the fears were merely nightmare, and our society has proved itself an efficient ally of the Association. The society closes its first decade justly gratified by success and full of hope for the future. American geologists are no longer a disorderly lot of irregulars marching in awkward squads, but they form a reasonably compact body, though as individuals they owe allegiance to Canada, the United States, Mexico, or Brazil.

But this society has to do with the world outside of itself and outside of its immediate line of thought. It must have more to do with that world in the future, if the outcome for science is to be what it should be, for the time is approaching rapidly when we must seek large sums for aid in prosecuting our work. In a proper sense this is a utilitarian age. Everywhere the feeling grows that the earth is for man, for the rich and the poor alike; that those things only are good which benefit mankind by elevating the mental or physical conditions. There appears at first glance to be very little connection between great manufacturing interests on one hand and stone pecking at the roadside or the counting of striæ on a fossil on the other, yet a geologist rarely publishes the results of a vacation study without enabling somebody else to improve his condition thereby. The speaker then went on to relate several instances showing the intimate connection between geological studies and the proper development of the economic resources of the country. Among the striking instances cited were the discovery of the importance of the coal fields of Maryland, the determination of the absence of coal strata in New York State, that of the value of the salt lands in Michigan, and the announcement of the occurrence of vast bodies of iron ore in the Lake Superior region. Results of the highest economic importance have followed from investigations undertaken for purely scientific reasons, and experience has shown over and over again the value to the several States and to the nation at large arising from geological surveys carried on by trained scientists.

F. C. Phillips has experimented with a view to producing better lubricants for glass stop-cocks than those in ordinary use, and he finds that the following mixture lubricates well, is translucent, adheres to the glass, and is not saponifiable: Pure rubber, 70; soft spermaceti, 25; soft paraffin, 5. The materials were thoroughly mixed while hot, the rubber being melted first and the other ingredients stirred in. A little more soft paraffin should be used in winter than in summer. Still better results were obtained by mixing pure and fresh rubber, 70, with yellow beeswax, 30. The rubber was heated in a covered vessel until thoroughly melted, the wax added, and the hot mixture well stirred. This lubricant is quite translucent in thin layers, and protects stop-cocks from sticking, even when used for concentrated solutions of caustic alkalies. To keep the rubber mixtures in the best possible condition, they should not be exposed to air longer than necessary when heating, and they ought to be preserved in closed bottles. The stop-cocks should occasionally be thoroughly cleaned and recoated with the rubber mixture.—Journ. Am. Chem. Soc., xx., 678.

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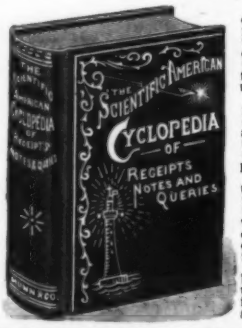

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